EAST WEST UNIVERSITY

INTERNSHIP REPORT

ON

POWER GENERATION,TRANSMISSION,DISTRIBUTION
AND PROTECTION SYSTEM OF THE EQUIPMENTS OF
ASHUGANJ POWER STATION COMPANY LIMITED (APSCL)

By

Muhammad Asif Iqbal Chy
2008-1-80-053
Md. Lutfar Rahman
2008-1-80-054
Asifur Rahman
2008-2-80-002

Department of Electrical and Electronic Engineering
Faculty of Science and Engineering
East West University

In partial fulfillment of the requirements for the degree of
Bachelor of Science in Electrical and Electronic Engineering

(B.Sc. in EEE)
Spring ,2012

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Approved By

____
Academic Advisor
S. M. Shariar Rashid

____
Academic Advisor
Ms.Tahseen Kamal

____
Department Chairperson
Dr. Khairul Alam

ASHUGANJ POWER STATION COMPANY LTD. (APSCL)
(An Enterprise of Bangladesh Power Development Board)

CIRIFICATION FOR INDUSTRIAL ATTACHMENT
TRAINING PROGRAMME

Certified that Muhammad Asif Iqbal Chy, Student. ID No- 2008-1-80-053 of Electrical & Electronic Engineering Départément of East- West University, Dhaka, has participated the Industrial Attachment Training Program from 26-12-2011 to 11-01-2012 and successfully completed the course.

Rahman
11-01-2012

Course Coordinator
&
Manager (HRD)
Ashuganj Power Station Company Ltd.
Ashuganj, B-Baria.

ASHUGANJ POWER STATION COMPANY LTD. (APSCL)
(An Enterprise of Bangladesh Power Development Board)

CIRIFICATION FOR INDUSTRIAL ATTACHMENT
TRAINING PROGRAMME

Certified that Md.Lutfar Rahman, Student. ID No- 2008-1-80-054 of Electrical & Electronic Engineering Départment of East- West University, Dhaka, has participated the Industrial Attachment Training Program from 26-12-2011 to 11-01-2012 and successfully completed the course.

Rahman.
11-01-2012

Course Coordinator
&
Manager (HRD)
Ashuganj Power Station Company Ltd.
Ashuganj, B-Baria.

ASHUGANJ POWER STATION COMPANY LTD. (APSCL)
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APSCL

CIRIFICATION FOR INDUSTRIAL ATTACHMENT
TRAINING PROGRAMME

Certified that Asifur Rahman, Student. ID No- 2008-2-80-002 of Electrical & Electronic Engineering Départment of East- West University, Dhaka, has participated the Industrial Attachment Training Program from 26-12-2011 to 11-01-2012 and successfully completed the course.

11-01-2012

Course Coordinator
&
Manager (HRD)
Ashuganj Power Station Company Ltd.
Ashuganj, B-Baria.

Acknowledgment

First and foremost we would like to thank the Almighty Allah for providing us the gift of life, and then we would like to thank our parents for their support, which helps us to complete ours study.

We would like to place my great pleasure and sincere gratitude and respect to Engr. Md. Mahfuzur Rahman, Finance Director of APSCL and Md Lutfar Rahman (HRM), who help us to get permission and allowing us to do the internship. And Engr. Achinta Kumer Sarker, DGM (mm), Engr. Md. Shahabuddin, Manager (CCPP), Engr. Noor Mohammad, Manager (Sub-station), Engr. Md. A.K.M Yaqub, Manager (Generator), Engr. Md. Anwar Hossain, Manager (Operation), Engr. Bikash Ranjan Roy, Manager (Instrumentation & Control) of APSCL and their senior Engineer for letting us work in their team.

We would also like to thank our advisor S. M. Shahriar Rashid, Lecturer Department of Electrical & Electronic Engineering, & Tahsin Kamal Senior Lecturer Department of Electrical & Electronic Engineering of East West University, Bangladesh.

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We would also like to thank Engr. Md. Kamruzzaman, Senior Engineer (Generator & Switchgear Protection.), Engr. Md. Fazle Hassan Siddiqui, Assistant Engineer & Engr. Kh. Nazmul Amin (Combine Cycle Power Plant), Engr. Julhash Naim, Junior Engineer, (Operation), who had given us their precious time to collect related data of our report and also helped us to understand many related matters.

We are also grateful to all of our teachers and friends for their cooperation and encouragement throughout our whole academic life in EWU.

Executive Summary

A shortage of electric energy is the biggest problem to the economical growth of any country. The power sector of Bangladesh faced various problems such as: lack of supply capacity, frequent power cuts, unacceptable generation of power, and poor financial and operational performance and etc.

In Bangladesh, The present maximum demand of electricity varies from 4,500 MW to 5,600 MW and it is expected to rise up to 7,000 MW within the next two years. But maximum generation available is between 3,800 MW and 4,600 MW. The difference between maximum demand and maximum generation of power is approximately 2,000 MW. Due to oldest set-up and de rated efficiency of the maximum power plant

In APSCL(Ashuganj Power Station Company Ltd), where we have done our internship, has 9 units with installed capacity of 777MW. But its present de rated capacity is 731MW and dependable capacity at a delivery point 624MW. Ashuganj Power Station fulfills about 15% of power requirements of the total country. Manpower at APSCL is almost 525 (as on 30-06-2011) on regular basis, which plays a vital role in the job market of developing country.

Through this internship, we observe how a power station can generate the power and transmitted the power and also protect the power system equipment. And also learned about different systems and equipment, which is used for power generation, transmisson, distribution and protection. In APSCL, total 9 unit exsits. we woks in different section in different days, such as generation section, in generation section we observe unit 1&2 steam turbine generator(64MW) and its protection system. Combine Cycle power plant section, in this section we observe GT1 & GT2 and ST and its generation system, protection system and working princpal. Sub-Station section, in this section we observe the operation of sub-station equipments and protection of this equipments, such as; Power transformer, Auxilary Transformer, Bus Bar, Current Transformer, Potential Teansformer, Circuit Breaker(SF6, Minimum Oil, MCCB), Isolator, Insulator and different types of cables. In operation section, we observe the unit 3, 4 & 5 and its total operation, how steam is produced in the boiler and gose to the turbine section with a specific temperature and pressure. By this internship we could relate our theoritical knowledge with practical experience.

Schedule of the internship work will follow afterward.

Date	Division	Time(1st&2nd session)	Duration	Mentor
26-12-2011	Total Plant Overview	08am to 04pm	7 hour	Engr.Achinta Kumer Sarker
27-12-2011	Combine Cycle Power Plant (Gas Generator)	08am to 04pm	7 hour	Engr.Md. FazleHassan Siddiqui
28-12-2011	Combine Cycle Power Plant (Steam Generator)	08am to 04pm	7 hour	Engr.Kh. Nazmul Amin
29-12-2011	Sub-Station (Equipment & Works)	08am to 04pm	7 hour	EngrNoor Mohammad
31-12-2011	Sub-Station (Bus Bar System)	08am to 04pm	7 hour	EngrNoor Mohammad
01-01-2012	Sub-Station (Protection System)	08am to 04pm	7 hour	EngrNoor Mohammad
02-01-2012	Generator (Unit 1 & 2)	08am to 04pm	7 hour	Engr. Md. Kamruzzaman
03-01-2012	Generator (Unit 3, 4 & 5)	08am to 04pm	7 hour	Engr. Md. Kamruzzaman
04-01-2012	Generator (Protection Relay)	08am to 04pm	7 hour	Engr. Md. Kamruzzaman
05-01-2012	Operation (Gas & Water Treatment Plant)	08am to 04pm	7 hour	Engr. Julhash Naim
07-01-2012	Operation (Unit 1 & 2)	08am to 04pm	7 hour	Engr. Julhash Naim
08-01-2012	Operation (Unit 3, 4 & 5)	08am to 04pm	7 hour	Engr. Julhash Naim
09-01-2012	Instrumentation & Control (Unit 1 & 2)	08am to 04pm	7 hour	Engr. Bikash Ranjan Roy
10-01-2012	Instrumentation & Control (Unit 3, 4 & 5)	08am to 04pm	7 hour	Engr. Bikash Ranjan Roy
11-01-2012	Instrumentation & Control (Boiler Section)	08am to 04pm	7 hour	Engr. Bikash Ranjan Roy

Total=105 hour

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1. INTRODUCTION

Power generation sector is the most important sector for any nation because the economical growth is vastly depends on this sector. It is great opportunity to accomplish the internship in Ashuganj Power Station Company Limited (APSCL). It is the second largest power station in capacity all over the country. APSCL plays a major role to the national power and national economy by producing the 15 % power of total national grid. There are three types of power plants in APSCL such as Thermal power plant, Gas Turbine power plant and Combined cycle power plant. So here is lot of opportunity to learn about various types of power plant. During our internship we closely observed Generation section, operation section, substation section, instrumentation and control section. In this chapter concludes the overall idea about Ashuganj Power Station Company Limited, including the background, present capabilities and future plan.

1.1. **Company Profile:**

A brief description of Ashuganj Power Station Company Ltd.

(i) Name of the Company: Ashuganj Power Station Company Ltd.

(ii) Date of Incorporation: 28 June 2000

(iii) Registration No: C-40630 (2328)/2000 dt. 28.06.2000.

(iv) Location: 90 km North-East of Dhaka on the left bank of the river Meghna.

(v) Land : 311.22 Acres

(vi) Installed Capacity : 724 MW

(vii) Total number of plants : 3

(viii) Total Number of Units : 8

1.2. **Power Generation**

The APSCL has total 3 plants. There are two thermal power plants and a combined cycle power plant. The fuel used in APSCL is the natural Gas Supplied by TITAS Gas Transmission & Distribution Co. Ltd.

1.2.1. **Plant 1: Thermal Power Plant (Unit 1 & 2)**

Under Plant 1, there are two steam units, Unit-1 and Unit-2. These two units generate 64 MW each and in total 128 MW. Unit-1 and Unit-2 commissioned in 1970. Those units use water of Meghna River to make the steam.

1.2.2. **Plant 2: Combined Cycle Power Plant (CCPP)**

Under Plant 2, there are two gas turbine units GT-1 and GT-2and one steam turbine unit ST in the combined cycle power plant. The installed capacity of GT1 and GT2 is 56 MW each and in total 112 MW. Gas Turbine Units-GT1 and GT2 commissioned in 1982 and 1986 respectively.

Steam turbine is the waste heat recovery unit with capacity 34 MW was commissioned in 1984. The total capacity of this combined cycle power plant is 146 MW.

1.2.3. **Plant 3: Thermal Power Plant (Unit 3, 4 & 5)**

Under Plant 3, there are three steam power units, Unit-3, Unit-4 and Unit-5 in thermal power plant. The installed capacity of Unit-3, Unit-4 and Unit-5 is 150 MW each and in total is 450 MW. But presently the Unit-4 is out of the production due to the overhauling purpose. The three units Unit-3, Unit-4 and Unit-5 are commissioned in 1986, 1987 and 1988 respectively.

The fuel used in APSCL is natural gas and this natural gas supplied by Titas Gas Transmission & Distribution Co. Ltd., Bangladesh

1.3.**Background of the Company**

For a thermal Power Plant infrastructure facility like river, transportation for heavy equipments, fuel sourcing is mandatory. Considering the above mentioned facilities of Ashuganj government decided to setup a power station at Ashuganj in 1966. Ashuganj is situated near to the Titas Gas field and at the bank of river Meghna. 311 acres of land of the north-east side of the Meghna Railway Bridge was acquired. With the financial assistance of the German Govt. two (unit-1 and unit-2) units of 128MW capacity was established. In 1968 the formation of main equipments was started and by July 1970 the two units ware commissioned.

To establishing unit 3, 4 and 5, IDA, KFW (German Govt.), Kuwait and OPEC fund and ADB gave the financial support. The turbo-generator part was supplied and established by M/S BBC from Germany (at present ABB) and boiler part was made by IHI from Japan and supplied and established by M/S Mitsui and Co. from Japan. Others main equipment was supplied and installed by M/S BBC (Germany), M/S IHI (Japan), M/S KDC (Korea) and M/S PCC (Korea)

These three units were commissioned on December, 1986 and May, 1987 successively.

As the plan of establishing unit 3 and 4 was going on at the same time establish a combined cycle plant in Ashuganj by British financial support. The total capacity of this combined cycle plant is 146MW, where two gas turbine units are having 56MW capacity each and one steam turbine unit having a capacity of 34MW. The main equipment of this unit is made and established by GEC from England (at present ALSTOM, UK). As of the combined cycle plant GT-1, ST and GT-2 unit were commissioned in 1982, 1984 and 1986 consecutively.

1.4.**Formation of Company**

As a part of the Power Sector Development and Reform Program of the Government of Bangladesh (GOB) Ashuganj Power Station Company Ltd. (APSCL) has been incorporated under the Companies Act 1994 on 28 June 2000. The Registration No. of APSCL is 40630 (2328) / 2000. Ashuganj Power Station (APS) Complex with assets and liabilities had been transferred to the APSCL through a Provisional Vendor's Agreement signed between BPDB and APSCL on 22 May 2003. All the activities of the company started formally on 01 June 2003. From that day the overall activities of the Company along with operation, maintenance and development of the Power Station are vested upon a Management Team consisting of the Managing Director, the Director (Technical) & the Director (Finance). 51 % of total shares is held by BPDB and the rest 49% is distributed among Ministry of Finance, Ministry of Planning, Power Division, MOPEMR & Energy Division, MOPEMR of GOB.

1.5.**Vision:**

Already APSCL owned the second largest power generating station. They have a vision to maintain generating units efficiently and install new generating stations to generate more power. It is the vision to contribute more to the national economy also. The vision of APSCL is “To become the leading power generation company in Bangladesh”

1.6.**Mission:**

To achieve the vision, recently APSCL has taken some steps. They will install some efficient generating units with good installed capacity. They already start work. So now the mission of APSCL is "To increase Ashuganj Power Station's Generation Capacity to 1500MW by 2014"

Now a project is running at APSCL

Name Of The Project: Ashuganj 225MW Combined Cycle Power plant

Project Highlights: Combined cycle Power plant with a gas turbine unit and a steam turbine unit making it more efficient than existing plant. It will meet a part of the growing demand of Electricity.

1.7.**Objective:**

Enhance the station's dependable capacity in order to comply with the government's target to provide electricity for all by 2021 and increase overall thermal efficiency of the station by installing new plant in order to generate more power consuming the same amount of gas.

1.8.**Board of Directors APSCL:**

The list of Board of Directors of APSCL

Chairman: Mr. Foiz Ahamed Joint Secretary (Admin), Power Division, MOPEMR

Directors:

1) Mr. Shafat Ahmed Chowdhury
   Joint Secretary, Energy & Mineral Resources Division, MOPEMR
2) Dr. Md. Quamrul Ahsan
   Professor, Dept. of Electrical & Electronic Engineering, BUET
3) Mr. Md. Anwar Hosain
   Deputy Secretary (Development) Power Division, MOPEMR
4) Mr. Md. Harunur Rashid
   Director, Prime Minister's Office, Dhaka
5) Mr. Mamtaz Uddin Ahmed
   Past President & Council Member
   Institute of Cost & Management Accountants of Bangladesh
6) Mr. Abul Quasem
   Member (Generation), BPDB
7) Mr. Md. Shamsul Haque

Director, FBCCI, Dhaka.Nominated by Power Division

8) Mr. Md. Abduhu Ruhullah

GM, Commercial Operation, BPDB, Dhaka Nominated by Chairman of BPDB

9) Mr. Tamal Chacrabarty

Member (P&D), BPDB

10) Mr. Md. Nurul Alam P.Engg.

Managing Director, APSCL

1.9.**Number of Generator and their Production Capacity:**

Table 1.1: Number of unit and their production capacity.

SL I	PARTICULARS	GT# 1	GT# 2	ST(cc)	UNIT #1	UNIT #2	UNIT #3	UNIT# 4	UNIT # 5
1	Installed Capacity (MW)	56	56	34	64	64	150	150	150
2	Present Contracted Capacity MW	38	40	16-18	40-45	50	102	140	150
3	Date of Commissioning	15/11/82	23/03/86	28/03/84	17/08/70	8/7/1970	17-12-86	4/5/1987	21/03/88
4	Cost of fuel per unit Gen. TK.	1.30	1.30	0.00	0.93	0.87	0.90	0.90	0.79

1.10. **Present Situation of Generation:**

Table 1.2: Present situation of generation.

No.	PARTICULARS	GT#1	GT# 2	ST(cc)	UNIT # 1	UNIT # 2	UNIT # 3	UNIT # 4	UNIT # 5
1	Model & Capacity of Turbo-Generator	GEC, 69.6Mva 13.8 Kv	GEC 69.6 Mva 13.8 Kv	GEC, 43 Mva 13.8 kv	BBC Germany 80 Mva 11.0 kv	BBC Germany 80 Mva 11.0 kv	ABB Germany 190Mva 15.75 kv	ABB Germany 190 Mva 15.75 kv	ABB Germany 190 Mva 15.75 kv
2	Installed Capacity (Mw)	56	56	34	64	64	150	150	150
3	Present De-rated Capacity, MW	40	40	18	64	64	102	140	150
4	Date of Commissioning	15/11/82	23/03/86	28/03/84	17/08/70	8/7/1970	17/12/86	4/5/1987	21/03/88
5	Total hours run since Installation	150,56	114,68	87,034	231,011	20,371	186,821	183,865	164,933
6	Total Energy Generation to date , Gwh	5,96.68	6,607.73	1,734.07	10,575.44	9,744.33	22,328.50	21,306.43	29,767.39
7	Plant Factor %, 2010	71.77	85.52	31.05	56.15	86.03	81.74	53.45	83.77
8	Availability Factor %, 20	82.69	96.03	29.54	68.10	95.65	94.75	64.06	95.54
9	Station Thermal Efficien %	20.14	20.14	27.79	28.06	28.06	31.68	31.68	31.68

1.11. **Gas availability and usage:**

Ashuganj is strategic location of gas transmission system. There are several piping system has been tied up at Ashuganj specially Titas and GTCL installation. A good Gas pressure is maintaining at Ashuganj. Existing and rental power projects together there would be 982 MW at Ashuganj including units of under maintenance. So far APSCL is satisfied with the supplied pressure for its 9 units.

1.12. **Future projects of APSCL:**

Considering the future power demand, APSCL has started to undertake some projects in order to decommission the old and inefficient plant after the implementing the new projects. APSCL has already been floated a tender of 225MW CCPP project through their own arrangement of funding. According to schedule the 225 MW project is expected to be implemented last quarter of 2013.

The following are near future power project of APSCL:

(i) 225 MW CCPP Project, Tender already done on oct-nov, 2011

(ii) 450MW CCPP (North)

(iii)450MW CCPP (South)

1.13. **Scope and Methodology:**

This report focuses the total process of power generation including water resource management, boiler management, generator, combine cycle power plant and substation. In this report also mentioned the protection and maintenance of generator, boiler and substation. The instrumentation and control section are also discussed here.

During our internship period our instructor demonstrates various equipments and section of the power station. In that time based on their lecture we collect the information. Several times they give us some figures and tables. So the primary information is collect during internship from instructors. And the secondary source of data is the official web site of APSCL (www.apscl.com)

1.14. **Conclusion**

The overview of the APSCL is discussed in this chapter. From the beginning of the company of this company to present all the background, past and present capabilities has been discussed. The vision, mission and the future plan of the company also focused. APSCL go for their goal, already some projects work starts and more projects are under consideration. If APSCL fulfill their vision it will be a milestone in our country. It is expected that the three combined cycle power plants which will be setup in near future will be able to contribute not only to the national grid but also in the national economy.

Chapter 02

2. THERMAL POWER PLANT (TPP)

2.1. Introduction

APSCL provides maximum power from its thermal power plant. The total installed capacity of thermal power plant is 578 MW. Thermal power plant includes 5 steam units. Unit 1 and 2 has a capacity of 64 MW each. Unit 3, 4 and 5 has a capacity of 150 MW each. On 29-12-2011, 31-12-2011 and 01-01-2012, we observed the operation and different parts of Generator section at APSCL with the help of Engr. Md. Kamruzzaman. And we also spent 21 hours in Generator section of our total duration of internship.

2.2. Operation of TPP

Thermal power plant uses steam to force the turbine. This water is collected from the Meghna River. Then the water is sent to water treatment plant. River water contains various minerals. When the water comes out of the water treatment plant then it is highly pure and ready to go to boiler and then the turbine. This water is called Demi water.

Demi water is taken to the boiler using a pump. In APSCL water tube boiler is used.Water is fluxing inside the tube. Fuel gas methane (CH_4) is used which is supplied by TITAS GAS and through Force Draft Fan (FDF) air is given to burner. Then steam is produced and its temperature is 170-175°C and pressure is almost 30 bars. Then steam is taken to boiler and its temperature increases to 520-525°C by passing Super heater (SH) and pressure increases also to 135-138 bars. Then it is sent to High Pressure Turbine (HPT) and the exhaust steam is taken to Re-Heater (RH). Here its temperature decreases to 330-332°C and pressure decreases to 32 bars. Using RH these steams temperature becomes 520-525°C and pressure becomes 135-138 bars. Afterwards steam is taken in Intermediate Pressure Turbine (IPT) and then Low pressure Turbine (LPT). Then turbine starts to rotate the prime mover of generator at 3000 rpm. Thus electricity produces. The exhaust of LPT enters in condenser. Now both temperature and pressure becomes to 44-45°C and 0.1 bars. Later on, it is taken to Low Pressure Heater 1 (LPH1) and Low pressure Heater 2 (LPH2) at temperature 125-130°C and pressure is very low. This steam is taken now from Boiler Feed Pump (BFP) to boiler drum through High Pressure Heater 1 (HPH1) & High Pressure Heater 2 (HPH2) and again in turbine.

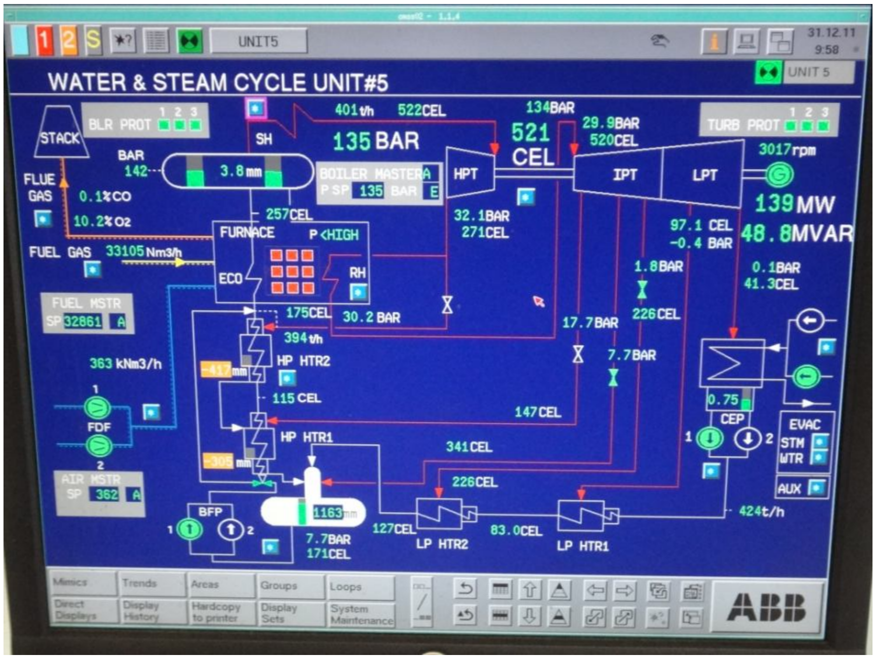

Figure 2.1 : Water and Steam Cycle unit-5

2.3. **Water**

Water is a crucial part for the TPP. River water is used for cooling of the exhaust steam and condenser. Another main objective of water is to be steam to force the turbine. When the river water used for cooling is send back to river then it is in ambient temperature so that the environment is not harmed. The following subsections discuss about how APSCL takes river water, filter that water, utilize, store and sent to the boiler and other purposes.

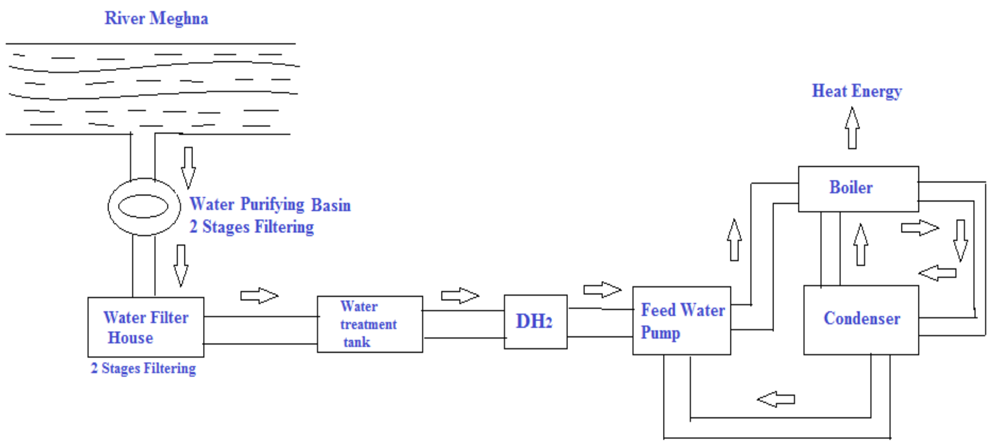

Figure 2.2: Water flow diagram

2.3.1. **Water filter house**

High purity feed water reduces the use of boiler chemicals because boiler blow-down is required less frequently with clean feed. This also results in lower fuel cost. Scale buildup is reduced due to a smaller absorption of impurities in the boiler feed water which polluted heat transfer surfaces. The lower level of impurities not only reduces corrosion rates in the boiler, but also reduces the erosion of the turbine blades. In the APSCL water filtering systems are designed to produce high purity feed water from many different water sources. For special applications, these systems can be combined with ion exchangers for more polishing of the feed water and de-gasifies to lower the oxygen content of the feed water in the APSCL.

Figure 2.3: Water Filter House

2.3.2. **Water treatment tank**

Feed water for boilers needs to be as pure as possible with a minimum of reasonable solids and dissolved impurities which cause corrosion, foaming and water carryover. Various chemical treatments have been employed over the years in the APSCL, the most successful being De-hydronization treatment. This contains a foam modifier that acts as a filtering blanket on the surface of the water that considerably purifies steam quality.

2.3.3. **De-Hydronization**

Dehydrogenation is an endothermic euuilibrium reaction. The process is about the decreasing pressure and increasing temperature. In general process temperature will increase with decreasing carbon number to maintain conversion at a pressure. Actually it is an improved process for the production of styrene through dehydrogenation of ethyl benzene in the presence of steam at high temperatures

2.4. **Fuel gas**

Fuel is a substance that absorbs energy then it can be extracted to perform mechanical work in a controlled manner. After ignition a burnable substance releases energy and reacts with oxygen in the air. In APSCL, Natural gas Supplied by TITAS Gas Transmission & Distribution Co. Ltd, Bangladesh is used as a fuel to ignite in the combustion chamber in the boiler and produce heat.

2.5. **Boiler**

The main purpose of boiler is to produce steam. In APSCL thermal power plant, each 5 units have a separated boiler. Boiler is defined as an enclosed vessel in which water is heated and circulated, either as hot water or as steam, for heating or power.

Figure 2.4 :Boiler

Table 2.1: Boiler description.

Description Boiler	Steam power plant	
	UNIT -1 & 2	Unit-3,4 & 5
Type	Natural Circulation Radiant Boiler (pressurized)	IHI-FWSR-504 Single drum, Natural cir, Single Reheat
Make	Babcock Germany	IHI,japan
Maximum evaporation capacity	270 t/h	500.4 t/h
Maximum allowable steam pressure, SH/RH	110 bar abs	171/50 bar abs
Normal working pressure, SH/RH	93 bar abs	138.5/36.6 Bar abs
Normal working temperature, SH/RH	525°C	523/523°C
Feed water temperature	229°C	246°C
Efficiency (MCR)	90%	86.8%

2.5.1. **Boiler working Principle**

The water stored in the vessel when heated to a desired temperature level by burning natural gases can be defined as a boiler. The steam produced by the boiler when heated is piped to turbine. Burner is a heart of the boiler which converters water to steam. This burner is heated by supplying fuels into it. The burner is heated by using natural gas. The natural gases are released into the burner through a special pipe which heats the burners. After the burners are heated up the gases or the fire from the burners are directly released on the boiler to heat up the water. The water can be boiled in the boiler depending on the two types of boilers used in the market. There are generally two types of boilers which use their own principles to produce heat.**Firetube Boilers**

Fire tube boilers are also known as shell boilers. These boilers are the most commonly used boilers in the market. In the fire tube or shell boilers the water is surrounded by the water. The water which surrounds the shell or fire tube is heated by sending the hot gases or fire which is produced by the burner through the shell or fire tube. The hot gases or fires are allowed four times through the tubes in the boiler before letting the out of the boilers. These tubes are generally set at the banks of the boilers. The fire tube boiler systems can release up to 25,000lbs or 750hp of steam per hour. About 80% of the boilers that are in use today belong to this particular category.

Water tube Boilers

In the Water tube Boilers the tubes are arranged vertically in the shell. Then the water is filled in the shell which is heated by sending the hot fuel or hot gases through the tubes. Generally Water tube boilers are built in rectangular shape with two or three drums. The drums are arranged at the top and bottom, where top drum is used to separate water and steam and the bottom drum is used to collect he sludge. Water tube boilers are usually utilized when more than 750hp of steam per hour is required.

2.5.2. Different Parts of Boiler

Boiler includes different auxiliary parts. Those are

1. Force Draft Fan
2. Water level indicator
3. Safety valve
4. Burner
5. Blow off cock
6. Steam stop valve
7. Feed check valve
8. Fusible plug
9. Flue gas
10. Pressure gauge
11. Main hole
12. Economizer
13. Super heater
14. Re-heater
15. Deaerator

2.6. **Turbine**

Turbine is a machine in which the kinetic energy of a moving fluid is converted to mechanical power by the impulse or reaction of the fluid with a series of buckets, paddles, or blades arrayed about the circumference of a wheel or cylinder. The heat energy is used to run the low pressure turbine (LPT) and the intermediate pressure turbine (IPT). Next high pressure turbine (HPT) is run by the help of low pressure and intermediate pressure turbine. Next generator rotor is run by the help of the pressure of HPT. At the end of this stage mechanical energy is produced. This energy is used to run the generator and the output of the generator gives us electrical energy. In APSCL, three different turbines are used. They differ by the Type of compounding, Division of steam flow, Type of steam flow, Type of blading. These are:

1. High pressure turbine (HPT)
2. Intermediate pressure turbine (IPT)
3. Low pressure turbine (LPT)

Figure 2.5: Turbine in APSCL

2.6.1. **High Pressure Turbine (HPT)**

The high pressure turbine is the first main engine turbine to receive steam from the main steam system. It is designed to efficiently extract work out of high pressure steam. As steam impacts the moving blade, it pushes the blade forward. This impact causes the steam to lose velocity without losing pressure.

2.6.2. Intermediate Pressure Turbine (IPT)

From the boiler re-heater, the steam enter into the intermediate pressure turbine. IPT blades are larger than HPT blades and blades are fixed with the shaft. Thus, steam hits the blades to rotate the shaft.

2.6.3. Low Pressure Turbine (LPT)

The LP turbine is located next to the IPT turbine. The LP turbine is a pressure compounded, either single or dual axial flow, condensing reaction turbine. The steam entering the LP turbine is at a significantly lower pressure than the steam entering the HP turbine. In order to efficiently extract work out of this lower pressure steam, reaction blading is used on the LP turbine.

2.7. Condenser

Condenser is a unit used to condense a substance from its gaseous state to its liquid state. The latent heat is given up by the substance and will transfer to the condenser coolant. Condensers are typically heat exchangers which have various designs and come in many sizes ranging from rather small to very large industrial-scale units used in plant processes.

2.8. Generator

A generator converts mechanical energy into electrical power. The energy conversion is based on the principle of the production of dynamically induced EMF. According to faraday's laws of electromagnetic induction, when a conductor cuts magnetic flux dynamically then induced EMF is produced in it. This EMF causes a current to flow if the conductor circuit is closed.

Table 2.2: Generator Rated Parameters

Description	Steam power plant	
	UNIT -1&2	Unit-3,4&5
Rated terminal output	64 MW	150 MW
Rated terminal voltage	11 KV±5%	15.75KV±5%
Rated power factor, cosφ	0.8	0.8
Rated current	4200 A/4690 A	6965 A
Rated frequency	50Hz	50Hz
Number of poles	2	2
Cooling system	Hydrogen cooled	Air cooled
Insulation class	F	F
Excitation voltage	249 V/267 A	323 V
Excitation current	1238 V/1327 A	1500 A

2.8.1. Generator main parts

The main parts of generators are following.

1) Stator
2) Rotor
3) KVA ratings
4) Armature
5) Carbon brushes
6) Collector slip rings
7) De-humidity fire
8) Jacking oil pump

1. Stator

The stator is the stationary part of a generator. The stator acts as the armature by receiving its influence from moving field coils on the rotor. The stator is made up of a soft-iron core, surrounded by the three-phase windings. The soft-iron core is made of soft iron plates which are perforated with respect isolated from each other. If one of the core from a whole would be to make the efficiency of the engine would be less because there are many eddy current losses than would have been. Building up a core of plates is called lamination. The plates are stacked in the form of a hollow cylinder, on the inside with cut-outs for the windings. The number of recesses will vary depending on the desired number of poles of the generator. The stator winding is connected to the three-phase load.

2. Rotor

The rotor is the non-stationary part of a rotary electric generator or alternator. It rotates because the wires and magnetic field of the motor are arranged so that a torque is developed about the rotor's axis. The central shaft of the rotor is coupled to the mechanical prime mover. The magnetic field is produced by conductors, or coils, wound into slots cut in the surface of the cylindrical iron rotor.

3. KVA ratings

The capacity of a synchronous generator is equal to the product of the voltage per phase, the current per phase, and the number of phases. It is normally stated in megavolt-amperes (MVA) for large generators or kilovolt-amperes (KVA) for small generators. The voltage rating of the generator is normally stated as the operating voltage between two of its three terminals i.e. the phase-to-phase voltage for a winding connected in delta, this is equal to the phase-winding voltage. For a winding connected in wye, it is equal to √3 times the phase-winding voltage.

4. Armature

Armature is a rotating part of an electromagnetic device consisting of copper wire wound around an iron core. It carries the current of the generators.

5. Carbon brushes

Carbon Brush is consisted with the small block of carbon. It is used to convey the current between the stationary and moving parts of the generator.

6. Collector slip rings

Carbon Brush is consisted with the small block of carbon. It is used to convey the current between the stationary and moving parts of the generator.

7. De-humidity fire

It is used for the absorbing of moisture when generator will be off. If moisture is inside the generator then the generator will be faulted. The absorb body of dehumidifier will absorbed the moisture. Here automation technique has been given inside the dehumidifier to absorb the moisture. The steam is going inside to the dehumidifier and the moisture is absorbed. The outside steam also goes inside and it will go outside after absorbing the moisture. The dehumidifier is rotated slowly.

8. Jacking Oil pump

A jacking oil pump also called a lift pump is commonly used on rotor shafts of steam driven Turbine Generators prior to startup or after shutdown to provide even cooling of the shaft and eliminate rotor distortion caused by sags due to weight and bows due to uneven cooling. The jacking oil pump uses high pressure oil supplied at the bearing journals to initiate an oil film and lift the shaft off its bearings. The rotor can then be put on a turning gear and rotated slowly to create even cooling and or roll out any distortions caused by the weight of the shaft while at rest. It also helps to maintain the oil film between shaft and the bearing till the rotor speed is adequate enough to maintain the film thickness and protects the shaft & bearing.

2.8.2. **Excitation**

Generators needed direct current to energize its magnetic field. A separate source is used to obtain the DC field current. This separate source is called an exciter. It can be rotating or static-type exciters are used for AC power generation systems. There are two types of rotating exciters: brush and brushless. The main difference between brush and brushless exciters is the method used to transfer the DC exciting current to the generator fields

The brush-type exciter can be mounted on the same shaft as the AC generator armature or can be placed separately from. When it is placed separately, the exciter is rotated by the AC generator through a drive belt. The distinguishing feature of the brush-type generator is that stationary brushes are used to transfer the DC exciting current to the rotating generator field. Current is transferred using rotating slip rings that are in contact with the brushes. Each collector ring is a hardened-steel forging that is mounted on the exciter shaft. Two collector rings are used on each exciter; each ring is fully insulated from the shaft and each other. The inner ring is usually wired for negative polarity, the outer ring for positive polarity.

In rotating-rectifier exciters, the brushes and slip rings are replaced by a rotating, solid-state rectifier assembly. The exciter armature, generator rotating assembly, and rectifier assembly are mounted on a common shaft. The rectifier assembly rotates with, but is insulated from, the generator shaft as well as from each winding.

Static exciters contain no moving parts. A portion of the AC from each phase of generator output is fed back to the field windings, as DC excitations, through a system of transformers, rectifiers, and reactors. An external source of DC is necessary for initial excitation of the field windings. On engine driven generators, the initial excitation may be obtained from the storage batteries used to start the engine or from control voltage at the switchgear.

In APSCL three types of excitation system is used. These are:

- AC Excitation System (in Steam Turbine unit -1,2) : Consists of a sub-pilot exciter of permanent magnet type, pilot exciter and the main ac exciter all coupled to the main generator on the same shaft.
- Static Excitation System (in Steam Turbine unit -3, 4, 5): The generator field is fed from a thyristor network via brushes.
- Brushless Excitation System (in Gas Turbine unit-1, 2): Consists of an exciter having stationary field system and a rotating armature diode rectifier assembly solidly coupled to the main generator rotor.

2.8.3. **Synchronization of Generator**

The process of connecting a generator to other AC generators is known as synchronization and is crucial for the generation of AC electrical power.

Here are the four conditions that must be met before the generator can be connected to the power grid.

- Synchronization of frequency
- Synchronization of voltage
- Synchronization of phase sequence
- Synchronization of phase angle

1. Synchronization of frequency

Synchronous speed is defined as rpm that corresponds to the grid frequency for a 50 Hz grid. A two-pole synchronous generator must spin at 3000 RPM. The generator must be driven by the prime mover at a speed such that the generated power frequency is equal its grid' frequency.

$$F = \frac{P \times N}{120}$$

F= frequency

P=No. of poles

N= Generator speed

2. Synchronization of voltage

The stator line voltage must be equal to the line voltage of power grid. It is adjusted by a control rheostat located on the switch panel. This rheostat controls the current in the voltage regulator coil and causes the alternator magnetic field to increase or decrease, controlling in turn, the alternator voltage. Voltage is very important, but not for the amount of amps flowing through the stator or for the direction of amps flowing in the stator.

3. Synchronization of voltages

The phase sequence of the generator must be same as the phase sequence of the powers grid. If the phase sequence of the powers grid is R1-Y1-B1 then the generators phase sequence must be R2-Y2-B2. If the phase sequences are different then it can be corrected by interchanging any two terminals on the generator side or on the grid side.

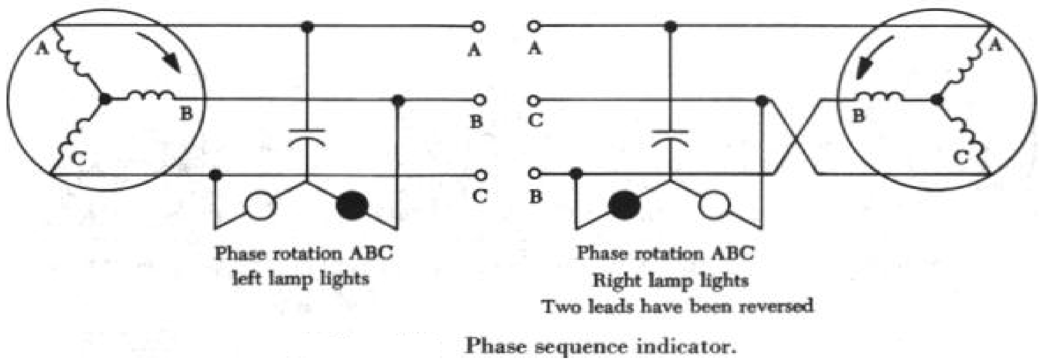

Figure 2.6 : Phase sequence indicator

4. Synchronization of Phase angle

If the phase difference between the voltages on either side of the open circuit breaker is not analysis to a small value, a large MW flow increase will suddenly occur once the circuit breaker is closed. Thus, the voltages phase angle should be as close to zero degrees as possible before closing the circuit breaker.

2.8.4. Cooling of generator

When current flows in a conductor, heat is generated. A generator has a lot of conductors and a lot of current flowing through the conductors. As such, it produces a lot of heat. If that heat is not removed then the windings will be damaged. In addition, in a synchronous generator, there are high currents flowing in the rotor winding which also generates heat which must be removed.

In APSCL there are three ways of generator cooling system.

1. Water cooling
2. Air cooling
3. Hydrogen cooling

1. Water Cooling

The stator winding of the generator is cooled by circulating demineralized water through hollow conductors of stator winding bars in a closed loop. The pump drives the water through the coolers filters and windings and discharge into a separate compartment of the sealed expansion tank. The water from center the expansion tank is again drawn by the pump cooled and re-circulates. If the pressure of demineralized water falls in the system below particular value, the other pump automatically starts. The closed circuit demineralized water is in turn cooled by demineralized water supplied from the station demineralization plant. The use of demineralized water on secondary side eliminates any accidental contamination of the closed circuit demineralized water which calls for tripping and shut down of the machine. The mechanical filters remove foreign particle in the water. These filters are periodically cleaned one by one.

2. Air Cooling

Air is used to cool a generator by circulating it through the generator to absorb heat and then exhausting the air to another area outside the generator. A continuous flow of air from outside the generator, through the generator, to another area outside the generator will cool the generator and rotor. The air entering the generator is cooler than the generator.

3. Hydrogen Cooling

Another way to cool the generator is to use hydrogen gas circulated through the generator and around the rotor to cool things. Hydrogen is seven to ten times better at transferring heat than air. That is, hydrogen is much better at absorbing heat and then at giving up that heat to another medium or area than air. This means that for the same size generator, if it is cooled with hydrogen versus air that more current can flow in the stator and rotor windings which means that more power can be produced. The same amount of power can be produced with a smaller generator cooled with hydrogen than one cooled with air, it is the typical reason for using hydrogen cooling.

2.8.5. **Generator Protection**

The following protections are used for generators in APSCL.

1. Over current with under voltage protection
2. Over voltage protection
3. Negative phase sequence
4. Loss of excitation
5. Reverse Power
6. Under or over frequency protection
7. Winding differential protection
8. Stator Earth Fault
9. Back-up earth fault
10. Rotor earth fault
11. Unit auxiliary transformer protection
12. Grid Protection
13. Generator vibration protection
14. Rotor Overload Protection

15. Generator Differential Protection

1. Over Current with Under Voltage Protection

Over current means excess current flowing through the equipment or conductor than the rated current. It may happen due to overload, short circuit, or ground fault. If the load cables come into contact with each other and short-circuit the generator, the generator windings could be damaged by excessive current unless the generator windings and load cables are protected by a circuit breaker. The circuit breaker breaks the circuit anytime there is a short circuit or overload condition in the load cables. One large load, consuming an amount of power at or near the maximum power output of the generator, could theoretically overload the generator in the event of a fault. In this case, one circuit breaker could trip the circuit and protect both the generator and the load. But small-load conductors connected directly to the larger generator load cables could likely burn up without drawing enough current to cause the circuit breaker of the generator set to open the circuit

If the load of the power generator decreases suddenly but synchronous speed is not adjusted on time, then a large current is flows through the generator to bus bar line may cause severe damage and hazard. To protect this differential relay is used in generator. If the current goes above certain level or amps, the relay first give the warning to the operator or switch alarm and then is break or trip the circuit breaker to protect the generator.

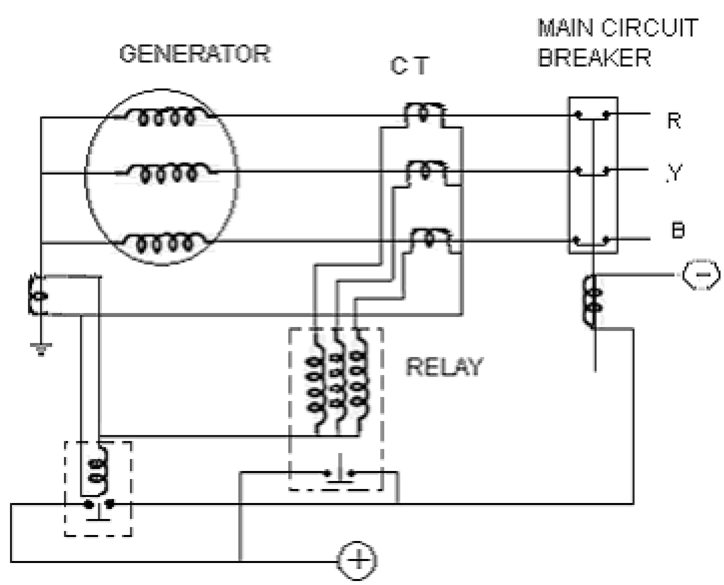

Figure 2.7: Over current Protection circuit

2. Over Voltage Protection

Over voltage occurs because of the increase in the speed of the prime mover due to sudden loss in the load on the generator. Generator over voltage does not occur in the turbo generator because the control governors of the turbo generators are very sensitive to the speed variation. But the over voltage protection is required for the hydro generator or gas turbine generators. The over voltage protection is provided by two over voltage relays have two units – one is the instantaneous relays which is set to pick up at 130 to 150% of the rated voltage and another unit is IDMT which is set to pick up at 110% of rated voltage. Over voltage may occur due to the defective voltage regulator and also due to manual control errors.

The reason for over voltages on a power system is divided into two main categories:

- Internal causes :(i) Switching surges (ii) Insulation failure (iii) Arcing ground (iv) Resonance.
- External causes: Lightning or thundering.

3. Negative Phase Sequence

Negative phase sequence protects the generator from overheating in the rotor due to unbalanced to the stator current. Negative sequence factor of stator current induces double frequency current in rotor because of overheating. Rotor temperature rises in proportion to I^2t. Negative sequence current interacts with normal positive sequence current to induce a double frequency current (120 Hz).

4. Loss of Excitation

If partial or complete loss of Excitation occurs on a synchronous generator then reactive power flows from the other generator into the generator. The real power is controlled by the Prime-Mover input, while the reactive power output is controlled by the Field Excitation. A loss of excitation will cause the generator to start drawing more and more reactive power over time. Over the first few seconds active power will stay relatively constant, but reactive power will continue to be absorbed from the rest of the system, and voltage levels will drop. Eventually, the magnetic field between the stator and rotor degrades too much so the loss of synchronism will occur.

To detect a loss of excitation with any machine loading the relay characteristic should be located with a circle diameter equal to direct axis synchronous reactance (X_d) of the generator. The offset mho loss of excitation relay with a negative offset equal to half the direct-axis transient reactance ($-X_d/2$) can detect a generator loss of synchronism for some system conditions.

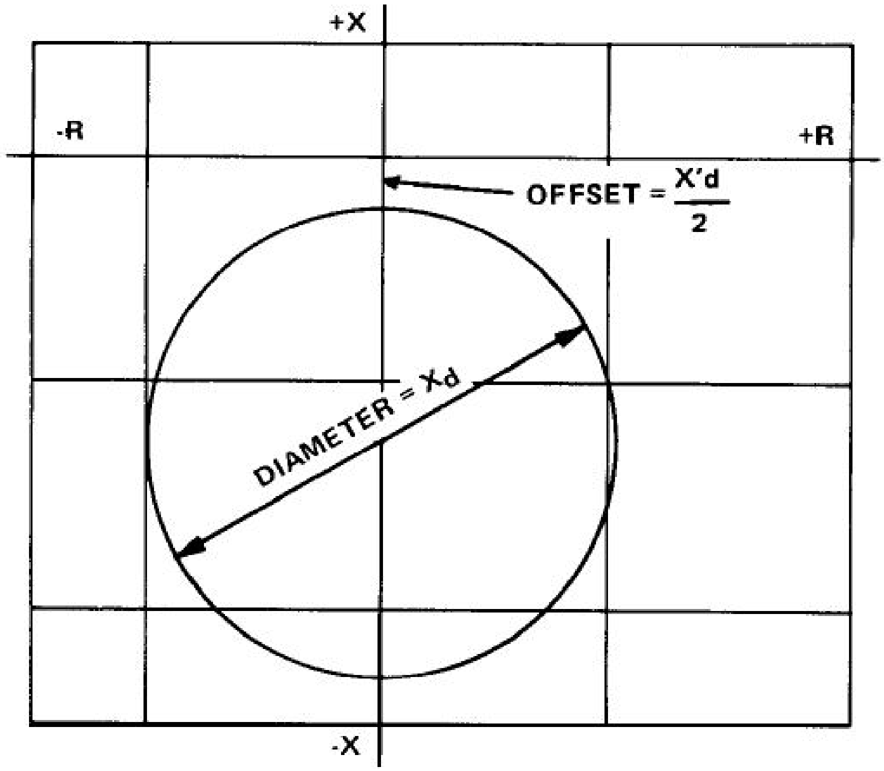

Figure 2.8 : Operating characteristics of loss of excitation relay

5. Reverse Power Protection

Reverse power protection is used for anti-motoring. This function is used for protection of prime mover. Motoring occurs when prime mover outputs are less than no load loss of generator, and prime mover can be damaged due to overheating during motoring. If the reverse power conditions stays for 3seconds before the trip occurs it cannot be due to nature of your plant loads (dynamic). There is bigger problem in parallel operation of DGs and STGs.

It is likely that the STG governors are not responding when there is load throw-off that leads to frequency shoot up. The DG governors must be closing the fuel valve completely on sensing the increased frequency and staying for 3seconds long to make the reverse power protection to operate.

During the motoring action of the generator, the power flows from the bus bars to the machine and the condition in the three phases are balanced. Hence a single element directional power relay sensing the direction of power flow in any one phase is sufficient. The CTs for reverse power protection may be both at the neutral end or the bus bar and of the generator winding. The setting depends on the type of prime mover. International time lag is provided in the reverse power protection so as that the protection does not operate during system disturbances and power setting.

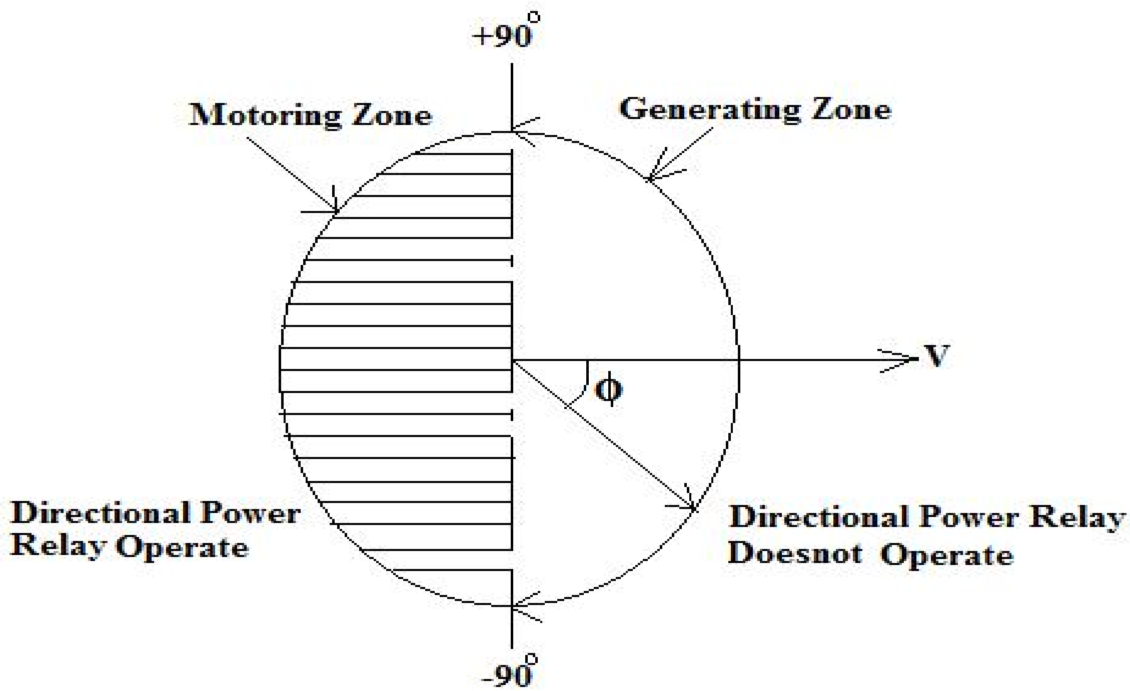

Figure 2.9 : operational characteristics of reverse power protection

In a steam-turbine, the low pressure blades will overheat with the lack of steam flow. Diesel and gas-turbine units draw large amounts of motoring power, with possible mechanical problems. In the case of diesels, the hazard of a fire and/or explosion may occur due to unburnt fuel. Therefore, anti-motoring protection is recommended whenever the unit may be connected to a source of motoring power. Where a non-electrical type of protection is in use, as may be the case with a steam turbine unit, the 32 relay provides a means of supervising this condition to prevent opening the generator breaker before the prime mover has shut down. Time delay should be set for about 5-30 seconds, providing enough time for the controls to pick up load

6. Under or Over frequency Protection

(i) Over frequency operation

Over frequency results from the excess generation and it can easily be corrected by reduction in the power outputs with the help of the governor or manual control.

(ii) Under frequency operation

Under frequency occurs due to the excess. During an overload, generation capability of the generator increases and reduction in frequency occurs. The power system survives only if we drop the load so that the generator output becomes equal or greater than the connected load. If the load increases the generation, then frequency will drop and load need to shed down to create the balance between the generator and the connected load. The rate at which frequency drops depends on the time, amount of overload and also on the load and generator variations as the frequency changes. Frequency decay occurs within the seconds so it cannot be corrected manually.

Therefore automatic load shedding facility needs to be applied. These schemes drops load in steps as the frequency decays. Generally load shedding drops 20 to 50% of load in four to six frequency steps. Load shedding scheme works by tripping the substation feeders to decrease the system load. Generally automatic load shedding schemes are designed to maintain the balance between the load connected and the generator.

The present practice is to use the under frequency relays at various load points so as to drop the load in steps until the declined frequency return to normal. Non essential load is removed first when decline in frequency occurs. The setting of the under frequency relays based on the most probable condition occurs and also depend upon the worst case possibilities.

During the overload conditions, load shedding must occur before the operation of the under frequency relays. In other words load must be shed before the generators are tripped.

7. Winding differential protection

Differential protection is a unit scheme that compares the current on the primary side of a transformer with secondary side. Where a difference exists (other than that due to the voltage ratio) it is assumed that the transformer has developed a fault and the plant is automatically disconnected by tripping the relevant circuit breakers.

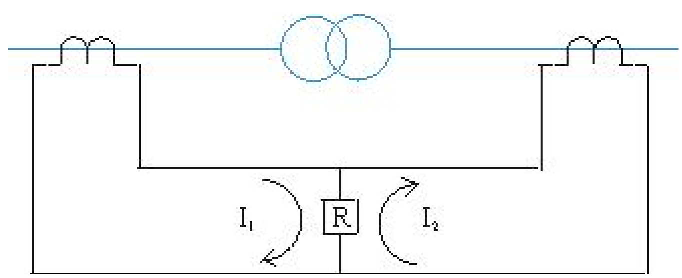

Figure 2.10 : Differential protection

Under normal conditions I1and I2 are equal and opposite such that the resultant current through the relay is zero. An internal fault produces an unbalance or 'spill' current that is detected by the relay, leading to operation.

8. Stator Earth Fault

To detect this type of fault within a generator is one of the important protection tasks. This contribution focuses on the stator earth fault protection in general and highlights a principle which covers 100 % of the stator winding. When generator neutral is earthed through high impedance, differential protection does not protect the complete alternator stator winding against with earth faults; hence a separate sensitive earth faults protection is necessary. The method for sensitive earth fault protection depends upon the generator connection.

The alternative methods are employed for neutral connection.

- The neutral connection through resistor which limits the maximum earth fault current to much lower value than full load current (fig: a) this method is preferred for large units.
- The neutral connected through a voltage transformer. The earth fault current is limited to the magnetizing current of the voltage transformer plus the zero sequence current of generator

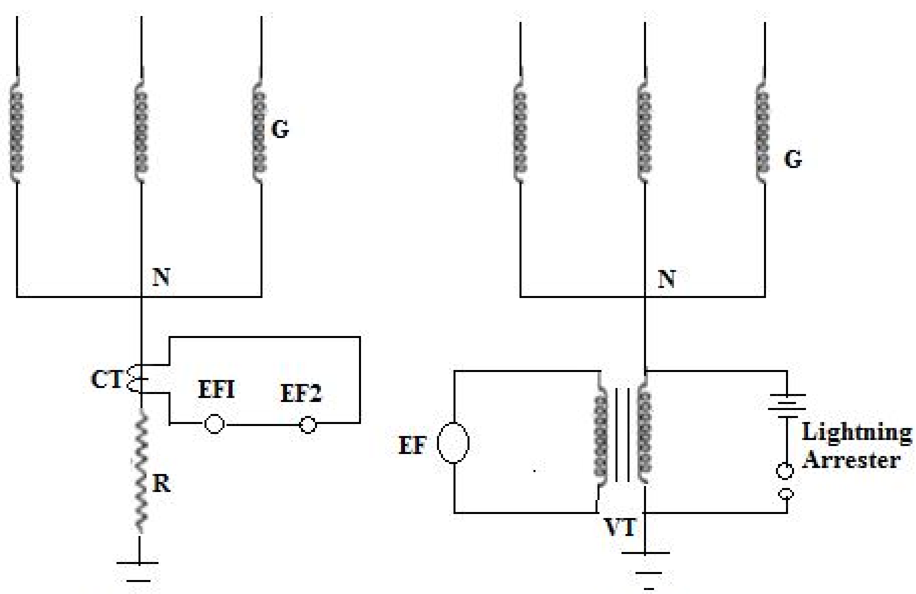

Figure 2.11 :Stator earth fault protection

A coupling Transformer is connected in neutral to ground circuit. A coded signal current is continuously injected into stator winding through the coupling transformer. The frequency of coded signal is 12.5Hz.during normal condition the signal fed into stator winding flows only into stray capacitance of generator and directly connected system in case of earth fault, the capacitance is by passed and the monitoring current increases. The increases in monitoring current are sensed by the measuring system.

The protection covers 5 to 20% of stator winding from the neutral end. The remaining 80%winding is protected by differential protection or earth fault protection.

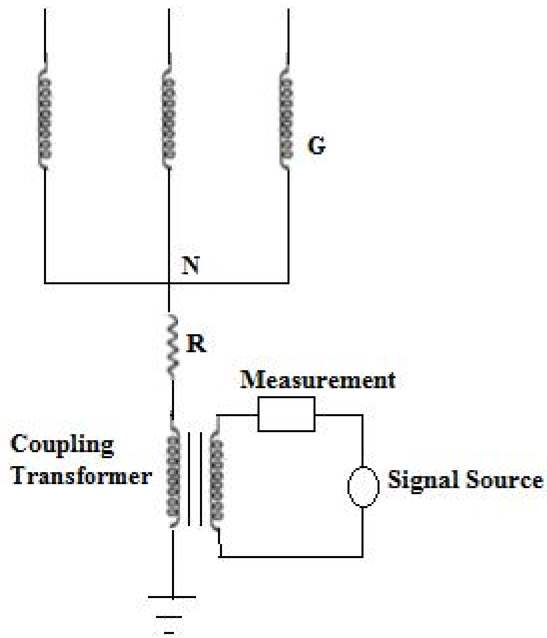

Figure 2.12 : Stator earth fault protection

9. Back-up earth fault

In this protection scheme the restricted earth fault relay is used. In any case if this relay does not work, then the backup earth fault relay is there to support the protection system.

Ashuganj A sensitive rotor earth fault protection is required for large generators. Two protective stages are necessary due to the risk of a double earth fault and the possibility of big damages on the generator side. One is for alarm and one is for trip. A single ground fault does not cause flow of current since the rotor circuit is undergrounded. When the second ground fault occurs part of the rotor winding is by passed and the currents in the remaining protection May increase. This cause unbalances in rotor and may cause mechanical as well as thermal stresses resulting in damage to the rotor. In some case the vibrations have cause damage to bearings of rotor shaft. Such failures have caused extensively damage. Here a high resistance is connected across the rotor circuit. The center point of this is connected to the earth through a sensitive relay. The relay detects the earth faults for most of the rotor circuit except the center point of the rotor.

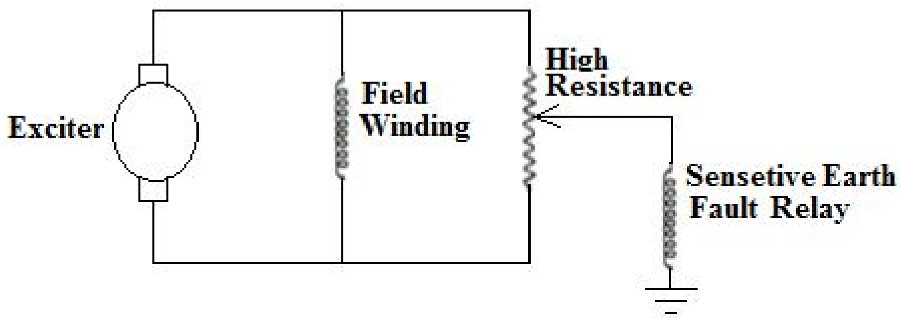

Figure 2.13: Rotor earth fault protection

10. Generator vibration protection

Generator vibration protection is very important protection system in between all protection schemes. It is essential for the long liability of generator and maximum working efficiency.

Vibration is defined as continuous, repetitive or periodic oscillation relative to a certain fixed reference. There are some reasons behind this generator vibration problem. Those are:-

- Lube oil film failure
- Low oil header temperature
- Shaft misalignment
- Water in oil
- Sudden change in combustion dynamics
- Abnormal closure of bleed air valves
- Rotor unbalance
- Faulty measuring device

Chapter: 03

3. COMBINED CYCLE POWER PLANT

3.1. **Introduction:**

Combined Cycle power plants are includes both gas and steam turbine generators, and by using these two types of generator it's supplying the power to the grid. Combined cycle power plants employ more than one thermodynamic cycle – Rankine (steam) and Brayton (gas). In a combined cycle power plant, gas turbine generator generates electricity by using gas as a fuel and producing the high temperature heat (like 520ºC to 569ºC) called waste heat, and by using this waste heat its make steam in a section called waste heat recovery unit. By using this steam, steam turbine generator generated additional electricity. So combined cycle power plant is more efficient than other. On 27-12-2011 and 28-12-2011, we observed the operation and equipment of Combined Cycle Power Plant at APSCL with the help of Engr. Fazle Hassan Siddiqui and Engr. Kh Nazmul Amin. And we also spent 14 hour in Combined Cycle power plant of our total duration of internship.

Combined Cycle power plant mainly consists of two major sections. These are:

1) Gas turbine generator section.
2) Steam turbine generator section

Combined Cycle power plant of APSCL includes two gas turbine generators (GT1, 1982 &GT2, 1986) and one steam turbine generator (ST, 1984). One gas turbine generator (GT1) is combined with steam turbine generator (ST) and other gas turbine generator (GT2) is open cycle means its exhaust its waste heat in the atmosphere. But at first GT1&GT2 are combined with ST, but it is not efficient as a required. So now GT1 is combined with ST.

Two gas turbine generators (GT1&GT2) are as it is same with configuration. So gas turbine generator consists of many parts, such as; Diesel Engine, used as a initial starter, Gearbox, used as a junction, which connect or disconnect the diesel engine with shaft, Exciter, used as a field excitation, Generator, Compressor, Combustion Chamber, Air Intake system, Diffuser.

And steam turbine consists of mainly two parts such as; Waste heat recovery unit and Generation unit. Waste heat recovery unit consists of different section and parts, such as; LP Evaporator, Forced flow section or HP Economizers, HP Evaporator, HP Super heater, Deaerarot, HP & LP Boiler Drum, Makeup water tank, Feed Water Pump and Circulating water pump and generation unit consists of steam turbine, condenser, generator, different types of valve and different types of pump. In this chapter, we discussed about above equipment and its operation and share our experience.

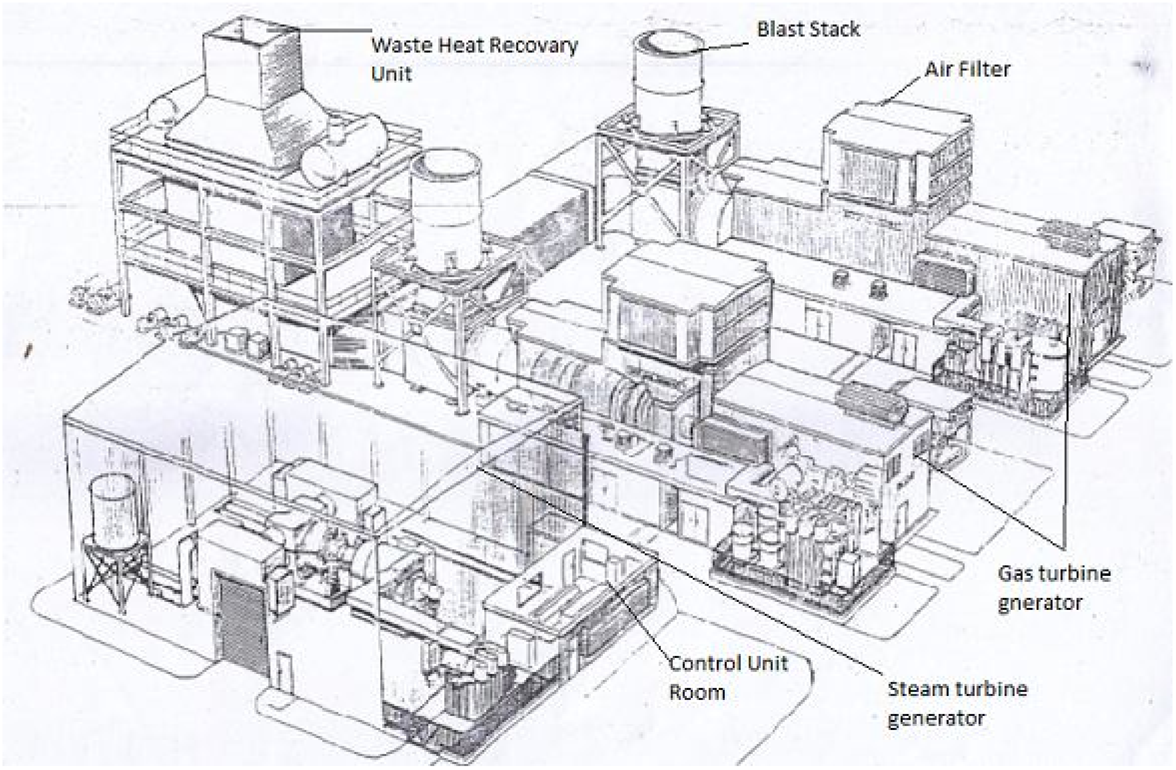

Figure 3.1: Layout of Combined Cycle Power Plant of APSCL .

Table 3.1: Total features of Combined Cycle Power Plant.

	Gas Turbine 1 (GT1	Gas Turbine 2 (GT2)	Steam Turbine (ST)
Name of the company	GEC, England	GEC, England	GEC, England
Year of commissioning	1982	1986	1984
Output Voltage level (KV)	13.8	13.8	13.8
Installed capacity (MW)	55.67 (for 35 ºC)	55.67 (for 35 ºC)	34
Derated capacity (MW)	35-38	40	16-18
Fuel in use	Flue gas	Flue gas	Steam
Inlet temperature (ºC)	1010	1010	569
Outlet temperature	569	569	80-120
Stage of turbine blade	-	-	17
Rotation speed (rpm)	3000	3000	3000
Efficiency %	20.14	20.14	27.79

3.2.Gas Turbine Generator Section

Gas turbine generator section is one of the most important sections of the combine cycle. Here gas is used as a fuel. Compressor sucks the air from the atmosphere through the three stage air filter, and sends it to the combustion chamber and done combustion into the combustion chamber.

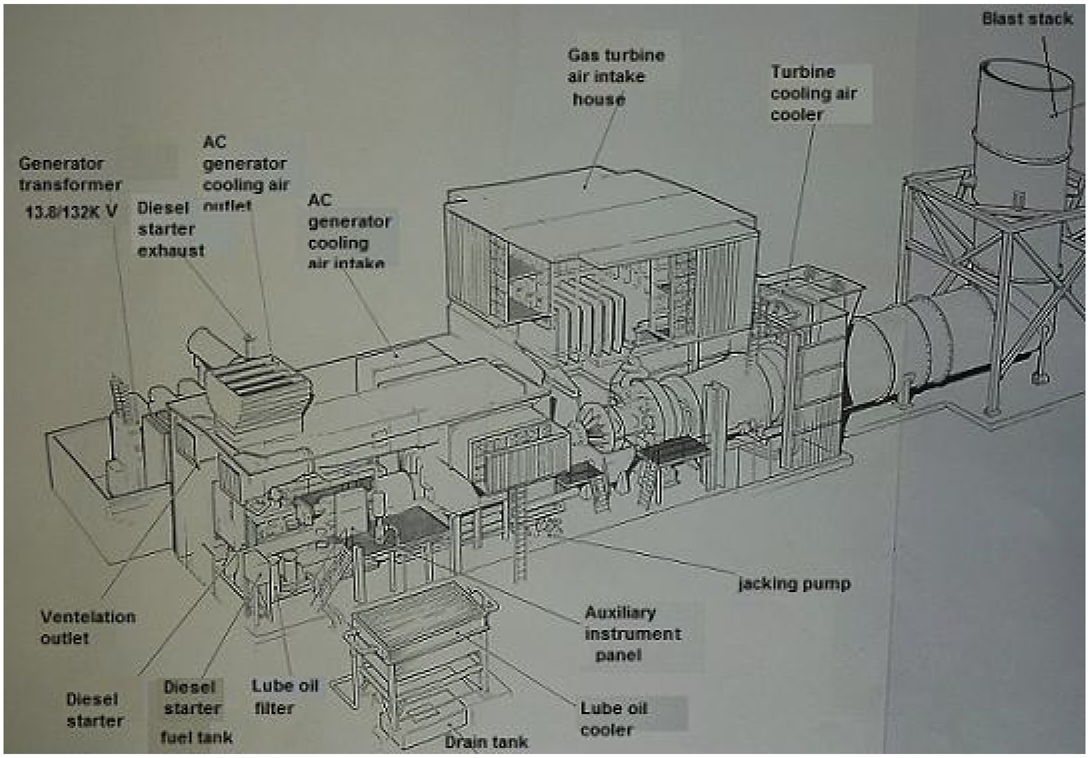

Figure 3.2:Layout of Gas Turbine Generator Section, 55.67MW.

3.2.1. Working Procedure of gas turbine generator section:

The compressor draws the air from the atmosphere through three stage air filter and supplies to the combustion chamber under the atmospheric pressure. Natural gas is used as a fuel for this system, which is injected into the combustion chamber in atomized form and burnt. It is a self-sustained system because if it's starts combustion one times it's run automatically. But initially it cannot starts automatically due to compressor does not takes any air for combustion, so it should be start up initially with a Diesel engine. Then the hot gas formed in the combustion chamber called flue gas and expands through the turbine, then producing a mechanical power. Which is able to rotate the turbine, due to rotation of turbine, compressor and rotating parts of generator are also rotate, because of turbine, compressor and generator are connected to the same shaft. Then the output power is produced.

3.3. **Parts of the gas turbine generator plant:**

Gas turbine generator plant consists of a Diesel Engine, Compressor, Combustion Chamber, Turbine and an AC Generator, Diffuser, Blast Stack.

3.3.1. **Diesel Engine:**

Diesel engine is used as a starting motor for gas turbine generator. It is very important part of gas turbine generator, because gas turbine generator has no self starter mechanism. The turbine only rotate when the compressor sacks the air from the atmosphere through the air inlet filter and use these air for combustion in a combustion chamber and after combustion when the flue gas hits the turbine.

But before the turbine starts the air cannot be enter the combustion chamber automatically because the compressor, turbine and generator are in same shaft. So diesel engine is connected here for initially rotate the compressor for helping to suck air from the atmosphere. That's why diesel engine is called initial starter. When the turbine rotate with the rated speed and compressor can suck the air automatically, diesel engine disconnect automatically through a gearbox. It's called synchronous self shifting clutch feature.

Figure 3.3: Diesel Engine of gas turbine generator section, 55.67MW.

Table 3.2: Condition of diesel engine.

rpm of turbine	Condition of
0 rpm	Diesel start
750 rpm	Ignition inside the combustion chamber
1800 rpm	Disconnect the diesel engine with the help of gearbox

3.3.2. **Compressor:**

Compressor is a mechanical device that sucks the air from atmosphere through the three stage air filter and increases its pressure by reducing its volume, and delivered to the combustion chamber. There are two types of blade one is rotate type blade and another is stationary blade. The rotate type blade sucks the air from the atmosphere and pushes it between the stationary type blades and increases its pressure as a ratio of 1:8 var.

There are two types of compressor, these are

a. Centrifugal compressor
b. Axial compressor

In APSCL, Axial compressor is used. It is a 13 stage compressor, consists of 726 blades.

3.3.3. **Combustion chamber:**

The combustion chamber consists of 10 burners which are set as round shape into the combustion chamber wall. Where pressurized air and fuel (natural gas) are mixed as a ratio of 15:1 and done combustion and produced flue gas with 1010ºC temperature.

3.3.4. **Gas Turbine:**

Gas turbine is very important part of a gas turbine generator plant and it is a mechanical device, which converts the heat energy to mechanical energy. Here in APSCL axial flow gas turbine and impulse type turbine is used. Flue gas from the combustion chamber with high temperature and pressure hits the turbine and thus do the mechanical work. The turbine capacity depends on ambient temperature, in APSCL‘s turbine capacity is 55.67MW for 35ºC temperature, but its design for 70MW in 15ºC temperature.

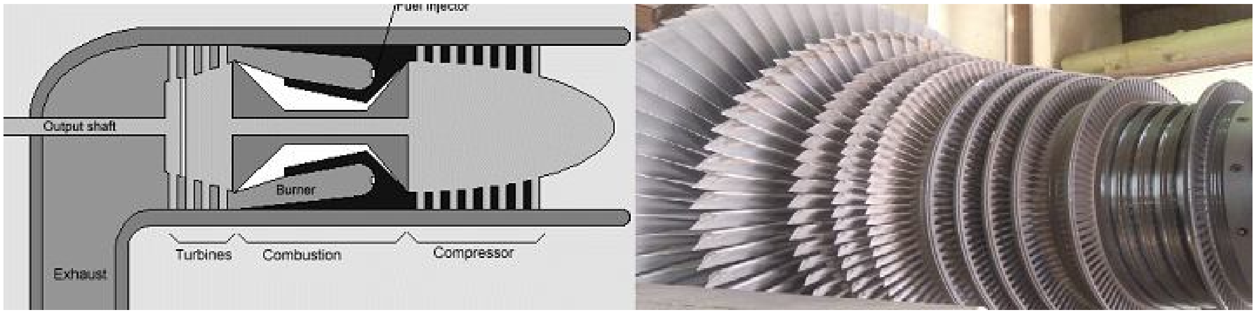

Figure 3.4: Turbine of gas turbine generator plant

3.3.5. **Gas Generator:**

Generator is an electromechanical device, which converted mechanical energy into electrical energy, for gas generator gas is used as a fuel. In APSCL use 3phase generator, which output voltage is 13.8KV and output power is 55.67MW.

Table 3.3: Feature of Gas generator.

Factor	
Pole number	2
Rated Speed	3000 rpm
Output voltage	13.8 KV
Output power	55.67 MW
De-rated output power	34 MW
Name of company	GEC, England

3.3.6. **Exciter:**

In APSCL, for gas turbine generator used Brushless exciter. Discussed in chapter 2, section 2.8.2.

3.3.7. **Gearbox:**

Gearbox is a mechanical device, which is used for connecting or disconnecting the diesel engine with the shaft. Initially the diesel engine is used as a starter for gas turbine. When gas turbine is rotating at the speed 1800rpm, and after exits this rated speed than diesel engine disconnect automatically with the help of the gearbox.

3.3.8. **Diffuser:**

Diffuser is a part of gas turbine plant, which is normally used for passing the waste heat from the output of the turbine. It is normally made by aluminum with insulation.

3.3.9. Blast Stack:

Blast stack is use for exhaust the waste heat from the diffuser section.

3.4. Major system of the gas turbine generator plant:

Gas turbine generator plants consists of five major systems, these are:

1. Fuel system.
2. Lube oil system.
3. Cooling system.
4. Turbine air intake system.
5. Barring or jacking system.

3.4.1. Fuel system:

Fuel system is the most important part of the total system; here natural gas is use as a fuel. When gas enters into the plant, before use it, its purified by many steps into a plant called gas treatment plant. In gas treatment plant, gas is passing through a hot water tube so gas released from unwanted particle. Than gas is enter into pot called knocked pot, where gas is released from moister, and gas enter into a two stage filter. And finally gas pressure can be control by a fuel valve governor or it can be use for bypassing gas. In APSCL, 0.4635m³ gas is used to generate per kwh power at 27-12-2011 and 0.4406m³ gas is used to generate per kwh power at 28-12-2011.

Figure 3.5: Fuel system of combine cycle power plant.

3.4.2. **Lube oil system:**

Lube oil is use for cooling and moving purpose. Shaft is hanging by the total four bearing, these bearing are always moving into a chamber, due to friction it produced heat so the purpose of absorbing heat of the chamber and smooth rotation, chamber is filled with the lube oil and lube oil is always circulating between lube oil cooling plant and bearing.. So bearing can move smoothly and absorbed the heat.

Figure 3.6: Lube Oil cooling plant

3.4.3. **Cooling system:**

Three types of cooling system is normally use in a gas turbine generator plant, these are:

i. Lube oil cooling system:

In APSCL, for the purpose of lube oil cooling system, here generally used air but due to over lifetime the system could not work properly, so now for the purpose of lube oil cooling, here used air and water also. In lube oil cooling plant, there are many narrow fins, through these fins lube oil circulated and become cool by the air and water.

ii. Generator cooling system:

In APSCL, gas turbine generator plant of combine cycle, air is used, for the purpose of generator cooling. This air is drawn by the air intake system.

iii. Turbine cooling system:

In APSCL, gas turbine generator plant of combine cycle, air is used, for the purpose of turbine cooling also. For the purpose of turbine cooling, in APSCL a semi heated air is flown through the center of the turbine or around the shaft such as 500ºC, where turbine temperature is around 1010ºC.

3.4.4. Turbine air intake system:

Three stage air filters is use for turbine air intake system, compressor suck the air from the atmosphere through the three stage air intake filter for the purpose of combustion.

3.4.5. Jacking system:

Jacking system is only use for plant shut down purpose. If the plant has to shut down immediately, the system is shutting off with a huge heat. If in this situation, shaft rotation is suddenly off, it has possibility to curve the shaft due to the overheating. So to avoid the situation shaft should be rotated slowly until it become cool. So here use a jacking system.

3.5.Steam Turbine Generator Section:

Steam turbine generator plant is one of the major parts in a combine cycle. In steam turbine generator, steam is used for rotation of turbine. In combine cycle, for steam turbine generator there is no fuel cost require for producing steam. Here in APSCL steam is produce by the using of waste heat, which is exhaust from the gas turbine. So steam turbine generator plays a vital rule in the combine cycle power plant.

3.5.1. Working Procedure of steam turbine generator section:

In a steam turbine generator, turbine is rotate by the flow of steam. Steam is produce in a waste heat recovery unit, by the use of waste heat from gas turbine generator. Here for producing steam, there is no furnace bad, just use of the high temperature such a520ºC to 569 º C waste heats from the exhaust of the gas turbine generator. Here use this heat in a waste heat recovery unit by the closing of damper, which is located in blast stack. Then produced steams, steams hit the turbine and turbine will rotate as well as power will produce.

3.6. **Parts of the steam turbine generator plant:**

Steam turbine generator plant mainly consists of two major parts, these are:

A. Waste Heat Recovery Unit.

B. Generator Unit.

3.6.1. **Waste heat recovery unit:**

Waste heat recovery unit is a unit, where steam is produced by using waste heat from the exhaust of gas turbine generator. Waste heat recovery unit is a very important part of the steam turbine generator plant of combine cycle. In APSCL, steam generating capacity of waste heat recovery unit is 126ton/h, but present de-rated capacity is 80ton/h.

Waste heat recovery unit consist of many parts such as LP Evaporator, Forced flow section or HP Economizers, HP Evaporator, HP Super heater, Deaerarot, HP & LP Boiler Drum, Makeup water tank, Feed Water Pump and Circulating water pump.

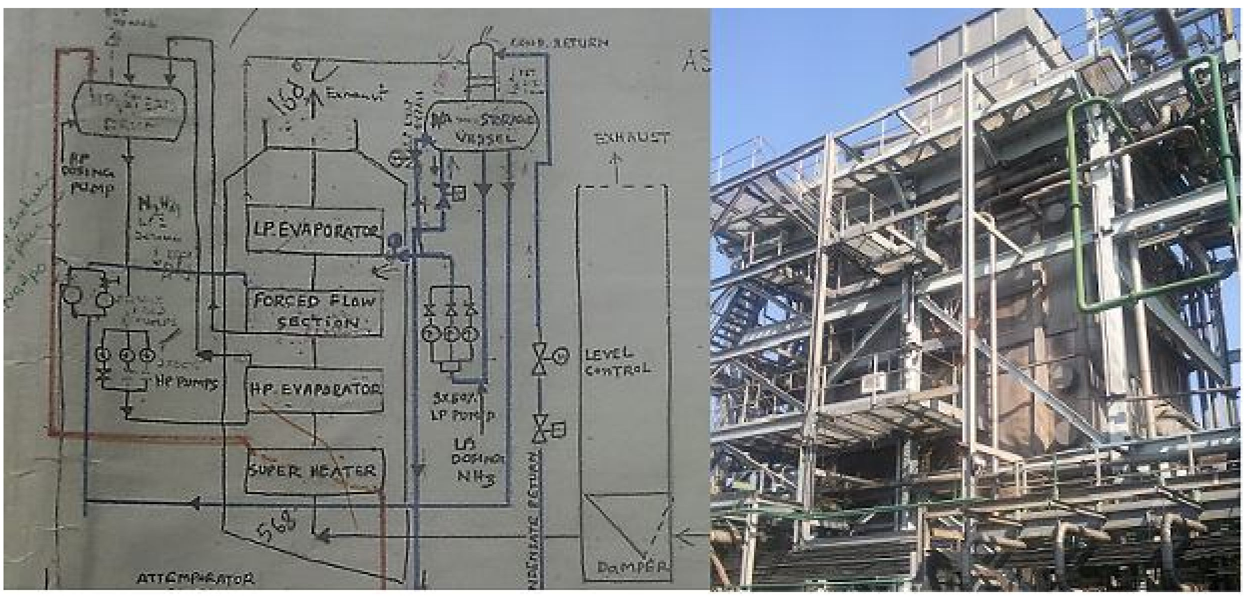

Figure 3.7: Waste Heat Recovery Unit of Steam turbine power plant.

I. LP Evaporator:

LP Evaporator is the upper part of waste heat recovery unit. This part is used for initial heating of the de-mineralized water for the purpose of improving efficiency. And it contains 180-220ºC temperature. It has two stages.

II. Forced flow section or HP Economizers:

Forced flow section is a section known as HP Economizer. In this stage de mineralized water becomes a steam with 50% moisture. And it contains 210-220ºC temperature.

III. HP Evaporator:

HP Evaporator is the three stage of the waste heat recovery unit. In this stage steam with 50% moister becomes 99% vapor including few moister. And it contains 238-240 ºC temperature.

IV. HP Super heater:

HP Super Heater is the last or lower stage of the waste heat recovery unit. It contains 520-569 ºC temperature. In this stage steam become a 100% pure steam without a single drop moister. After this stage steam goes to the steam turbine and hit the turbine and develops a mechanical energy.

V. Deaerarot:

Deaerator is the device that is used for the remove air and the other dissolved gases from the feed water, which coming from the condenser to steam generating boiler. The feed water is coming into a deaerator by the extraction pump. From the deaerator feed water goes to the LP boiler drum through the 1st stage LP Evaporator for the purpose of increasing its temperature.

VI. HP & LP Boiler Drum:

Waste heat recovery unit has two boiler drum, one is LP Boiler Drum & another is HP Boiler Drum.

Feed water is stored in a LP Boiler after passing through the two stages LP Evaporator. Than feed water goes to the HP Boiler Drum, by the help of feed water pump through the Forced Flow section or HP Economizer.

Figure 3.8: HP Boiler Drum of Waste Heat Recovery Unit.

VII. Makeup water tank:

Make up water tank is used for recovery the waste water. When steam hits the turbine it's lost some of its quantity. When steam is condensed into the condenser and become water then make up water tank supplies the lost amount of water for recovery the lost. In APSCL, makeup water tank contain approximately 2800 to 3300 letter of water.

Figure 3.9: Make-Up water Tank of steam turbine generator plant.

VIII. Feed Water Pump:

Here two feed water pump are used for the purpose of fed the water to HP Boiler drum. Two feed water pump are not use at a time, one is standby for emergency case.

Figure 3.10: Feed Water Pump of waste heat recovery unit.

IX. Circulation water pump:

Circulation water pump is used here for the purpose of circulation of the feed water through the different stage. In APSCL, there is fore circulating pump present.

3.6.2. **Generator Unit:**

Generator unit is the unit, where generate the power by using the steam. Steam hits the turbine and developed a mechanical energy, these energy rotate the turbine as well as rotate the rotor in the generator which is coupled with the turbine.

Generator unit consists of many parts as like as waste heat recovery unit such as steam turbine, condenser, generator, different types of valve and different types of pump.

I. Steam Turbine:

Steam turbine is the most important part of the generator unit. In APSCL 17th stage with 732 blades steam turbine is used.

II. Condenser:

Condenser is the most important part of the steam turbine generator plant, because condenser can converts the steam into water and recycle it.

Condenser is the devices which can condense the steam at the exhaust of the steam turbine and also reduce the pressure of the steam at the exhaust of the steam turbine.

There are two types of condenser, these are:

a. Jet condenser.
b. Surface condenser.

In APSCL, a surface condenser is used, because there is no direct contact between cooling water and the exhaust steam. It consists of a many horizontal tube. The cooling water flow through the tubes and exhaust steam over the surface of the tubes, then steam give up its heats to the water and become condensed. In APSCL, for condensed purpose generator unit has two condensers.

Figure 3.11: Condenser of steam turbine generator plant.

III. Generator:

I n APSCL, the steam turbine generator plant of the combine cycle uses a 2pole 3phase synchronous generator.

Table 3.4: Feature of Steam Turbine generator plant.

Factor	
Pole number	2
Rated Speed	3000 rpm
Output voltage	13.8 KV
Output power	34 MW
Name of company	GEC, England

IV. Different Types of Valve:

In APSCL, steam turbine generator plant of combine cycle use different types of valve for the purpose of controlling of the steam flow or bypassing the steam, such as: CIES Valve & Dump Valve.

CIES valve means combined Isolating Emergency Stop Valve, which is used for emergency stop. This type of valve is called isolation valve, because it is fully open or fully close type valve. Here also uses two Dump valve. Dump valve is used for bypassing the steam flow or control the steam flow, so this is a control type valve.

V. Different Types of Pump:

In APSCL, steam turbine generator plant of combined cycle use different types of pump for the different purpose. In generator unit, here use two types of pump are used one is called condenser extraction pump and another is called vacuum pump. Condenser extraction pump is used for draw water from the condenser to deaerator and vacuum pump is used for vacuuming purpose of the condenser.

3.7. **Total Operation of Combine Cycle Power Plant:**

Combined cycle power plant is more efficient than gas turbine or steam turbine power plant. The efficiency of the combine cycle power plant is near 35% and it is most cost effective. Because for the steam turbine generator, there is no fuel cost required.

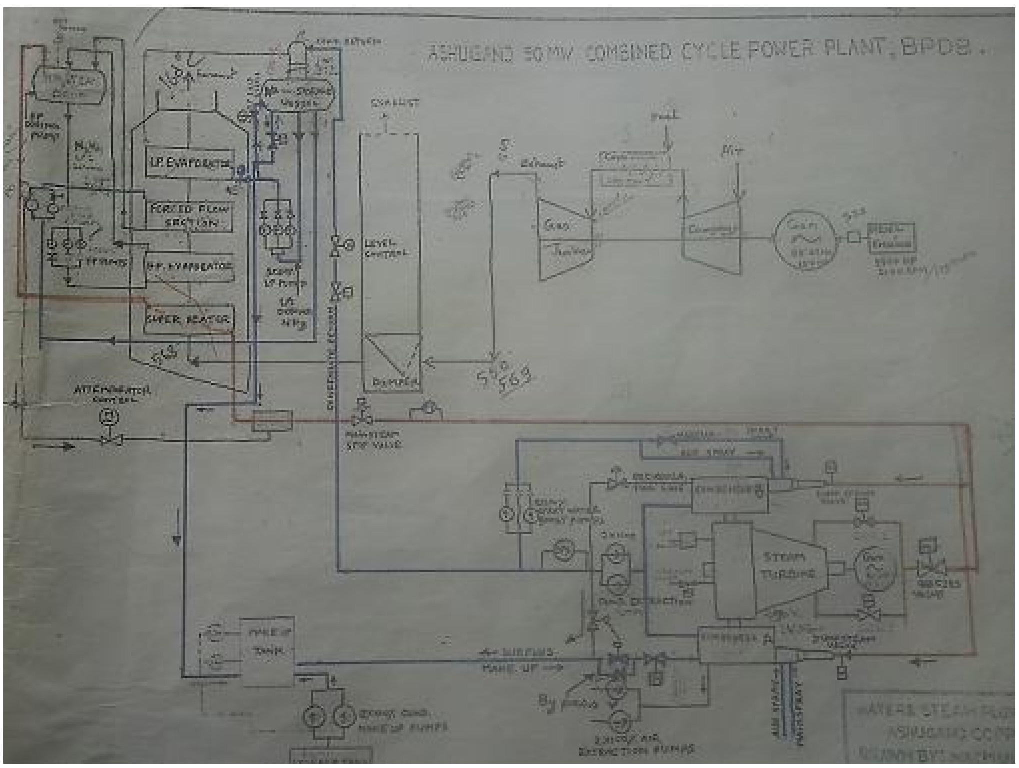

Figure 3.12: Total Plant Operation of CCPP

In gas turbine generator, rotation is started initially by the diesel engine, because it has no self started mechanism. Then compressor can suck the air from the atmosphere for the combustion. Then combustion take place in the combustion chamber as a ratio of 15:1 and produce flue gas with high temperature like 1010ºC. And hit the turbine and developed a mechanical rotation and produce the electrical power. After hitting the turbine flue gas contain almost 569 ºC temperature.

In combine cycle, this high temperature exhaust flue gas is used for generating steam, so there is no fuel require for generating steam. Then this steam is used for rotation of steam turbine.

3.8. **Control Unit of the Combine Cycle Power Plant:**

Control unit of the combine cycle is one of most important part of the plant. From the control unit or room each and every parts of the system can be controlled or monitored by the using of some equipment.

Control unit consists of many different equipment, such as: fault checking display, meter panel, temperature checking panel, vibration checking meter, boiler water level checking meter etc.

3.8.1. **Fault checking interface:**

Fault checking interface is an interface device which indicated is any fault occurs or not. If any fault occurs in the system its glow the light. If the fault is removing from the system light is automatically turn-off.

Figure 3.13: Fault Checking Interface of CCPP.

3.8.2. **Meter panel:**

Meter panel is the device which is only used for monitoring purpose. Meter panel shows every reading of the system, such as: output power, (active and reactive power), output voltage, frequency etc.

Figure 3.14: Meter Panel of CCPP.

3.8.3. **Temperature checking panel:**

Boiler temperature can be check from the control room, by using this panel. And also control the temperature of every stage of the boiler, because boiler should maintain a specified temperature for every stage.

Figure 3.15: Temperature measuring panel of CCPP.

3.8.4. **Vibration checking meter:**

Shaft vibration can be check from the control room by using vibration checking meter. If shaft vibration exits a minimum range it become unbalance, so it should be check.

Figure 3.16: Vibration checking meter of CCPP.

3.9. **Conclusion:**

Combined cycle power plant plays a vital rule in a power sector, due to its better efficiency. Combined cycle power plant consists of one or two gas turbine and one steam turbine. For steam turbine there is no fuel cost required, because of steam turbine plant produced its steam by using of waste heat, which come from the exhaust of the gas turbine plant. That’s why combined cycle power plant is more efficient than other.

In APSCL, combined cycle power plant consists of two gas turbine plant called GT1 (1982) & GT2 (1986) and one steam turbine plant called ST (1984). The installed capacity of GT1 &GT2 is

55.67MW and ST is 34MW. But present de-rated capacity is GT1 35 to 36MW and GT2 40MW and ST 16 to18MW. In APSCL, gas turbine GT1 is combined with steam turbine ST. For steam turbine there is no fuel cost required, because steam produce into a plant called waste heat recovery unit, which used waste heat with the temperature of 520º C to 569ºC from the exhaust of gas turbine (GT1). The steam producing capacity of waste heat recovery unit is 126 ton/h, but present de-rated capacity is 80 ton/h. And finally 0.4635 m^3 gas is used for per KWh at 27-12-2011 and 0.4406 m^3 gas is used for per KWh at 28-12-2011.

Chapter: 04

4. SUBSTATION

4.1.**Introduction:**

The electric power is produced at the power stations which are located at favorable places, generally quite away from the consumers. It is delivered to the consumers through a large network of transmission and distribution. This is accomplished by suitable apparatus called substation.

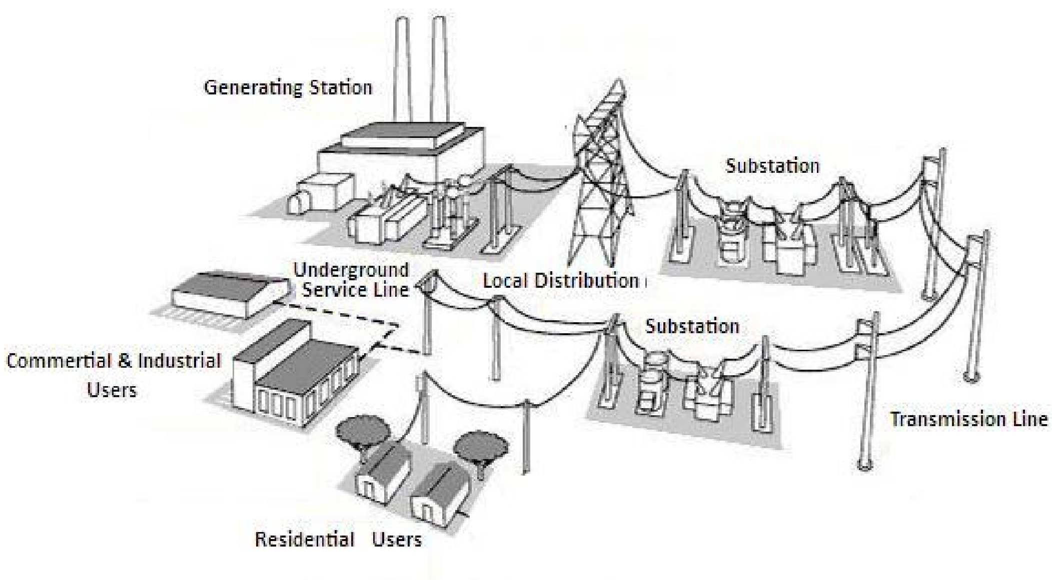

Figure 4.1: Power generation and distribution network .

A sub-station is the assembly of apparatus used to change characteristics of electric supply. Incoming power comes from generator to substation and transmission and distribution lines are outgoing from substation. In a substation there are measuring and protecting equipments for maintaining substation. Transformer is used to change the voltage level, measurement and protection. On 27-12-2011 and 28-12-2011, we observed the protection system, equipment and its operation of Sub-Station with the help of Engr. Noor Mohammad(Manager Substation) and we also spent almost 14hr of our total duration of internship.

In this chapter we shell confine attention on power transformer which on is change the voltage parameter and the current and voltage transformer as protecting and measuring scheme. We also focus on protecting equipments such as relay, circuit breaker, isolator, lightning arrester etc. Bus bar and transmission feeders we also include.

Figure 4.2: 230 KV Substation of APSCL.

4.2. **Equipments of Substation:**

A brief list of equipments used in substation of Ashuganj Power Station Company Ltd. (APSCL)

(i) Power Transformer
(ii) Instrument Transformer
    1) Current Transformer(CT)
    2) Potential Transformer (PT)
(iii) Circuit Breaker
    1) Oil Circuit Breaker
    2) SF6 Circuit Breaker
(iv) Isolator
(v) Earth Switch
(vi) Bus bar
(vii) Lightning Arrester
(viii) Wave trap
(ix) Transmission line
    1) Conductors
    2) Insulators
    3) Line Supports
(x) Outgoing feeder

4.3. **Power Transformer:**

Power transformer is generally installed for step up the voltage. For long line transmission high voltage in needed. We observe closely Unit 3 transformer. This unit produces 150 MW. Unit 1 generator is connected to the 132 kv bus bar and the generator output is 15.75 kv. So, a step up transformer is installed where primary winding voltage is 15.75 kv and secondary winding voltage is 132 kv. This transformer is made by HYOSUNG HEAVY INDUSTRIES LTD and made in KOREA.

Unit 3, 4, 5 is connected with 230 KV bus bar. So these units are steps up in two stages first 15.75 kv to 132 kv and 132 kv to 230 kv. Here three phase 132/230 kv step up transformer is used. Initially it is costly but the advantage is those units can connect with 132 kv bus bar when necessary. Bus bar is discussed in 4.9.

Figure 4.3: 15.75 KV/132 KV Power Transformers in APSCL.

Here three single phase transformer bank is used. Another practice is to install a single three phase transformer, it is required low space. But a problem with this system is if a single phase of three phase transformer is failed then the total transformer is off. But in a three single phase transformer bank other two phases can carry out. In this system the number transformer is increase.

4.3.1. **Breather**

Breather is an important part of transformer, by the breather the transformer breather-in or breather out the air from its body due to thermal contraction & expansion of oil mass. In APSCL clear view type Silicage1 is used almost every transformer for breather-in the air. Body and oil cup are made of transparent plastic. Another type of breather is Aluminum Body Silicage1 breather, but for this breather more quantity of Silicage1 in needed than clear view type. Silicage1 breather is to remove moisture from the air and it can absorb 20% of its own weight in moisture. The oil cup preventing continuous contact between the moist air and the Silicage1 therefore Silicage1 obtain a longer life.

Figure 4.4 : Clear view type Silicagel Breather of 132 KV Transformer.

4.3.2. **Cooling**

When the load is increase then winding temperature is increase and also increases the transformer temperature. Transformer winding is sinking in transformer oil. Transformer oil has sufficient insulation strength, and is excellent in heat conductivity. There are different meters to measure the oil temperature and winding temperature. If the internal temperature is goes more then 60-70^{o} C then the transformer will trip.

Figure 4.5 :Oil temperature and winding temperature meter of 132 KV Transformer.

The cooling system is ONAN (Oil Natural Air Natural) and ONAF (Oil Natural Air Forced).To cool the transformer there is heat radiator, in the radiator there are number of metal sheets aligned in parallel and number of cooling fan. The metal sheets absorbed heat from the transformer and radiate. Fans help to radiate heat very quickly. The fans are normally be controlled by an independent winding temperature relaying device.

Figure 4.6 : Heat radiator of 132 KV Transformer.

4.3.3. **Buchholz relay:**

Buchholz relay is an important safety device of all oil filled transformer. It is the gas operated relay. If an arc forms gas produced by decomposition of insulating oil accumulates in the top of the relay and relay sense gas and trip the transformer. It is in between the oil tank and transformer. It is in the pipe so we cannot observe this relay but our instructor say exactly where this relay located.

Figure 4.7 : Buchholz relay of 132 KV Transformer.

4.3.4. **Bushings:**

Bushing is used to connect the transformer coil to high voltage transmission line with proper insulation. Here solid porcelain bushing is used. A rod gap type lightning arrester is attached with the bushing. If a high voltage comes then it can easily ground this voltage without doing any harm of transformer.

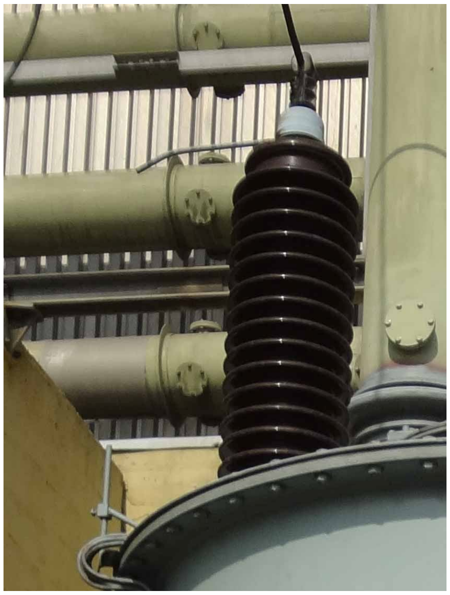

Figure 4.8 : Bushings of the 132 KV Transformer.

4.3.5. **Megger Test**

During our internship our instructor measures the transformer DC resistance of transformer. It is called Megger Test which is a test of the insulation properties of winding of the transformer. The megger uses much higher voltages about 5000 volt DC to check resistance than a normal Volt-ohm meter. The primary and secondary terminal are connects with the Megger and apply the voltage from external DC source. Result of the Megger test was 8.56 MΩ for the transformer of Unit-3. For this test all AC connection should disconnected.

Figure 4.9 : Megger Test .

4.4.**Instrument Transformer:**

Transformers that step down primary current or voltage to the secondary circuit with sufficient accuracy to connecting an instrument to the secondary is called instrument transformer. If high current flow though the measuring instruments then it can spoiled, so instrument transformer are used only low currents or low voltages are brought to the instrument.

Instrument transformer is two types

1) Current Transformer(CT)
2) Potential Transformer (PT)

4.4.1. **Current Transformer**

Current transformer is a kind of voltage step up transformer. It steps down the current with good accuracy. The meters and protecting devices cannot handle high current. So the current transformer steps down the current at primary side. If current changes at primary side for the good accuracy and ratio the changes and the amount of change can be identify from the secondary side.

The current transformer that is used in APSCL 132 kv substation is made by CROMPTON GREAVAS and made in INDIA. It is 145 kv current transformer with rated frequency 50 Hz. Its rated current is 1920 A. The short circuit is 31.5 KA in 1sec. It is the value of primary current that the CT should be able to bear up both thermally and dynamically without damage to the windings and the time specified is 1 second. The ratio of this current transformer is 800/1. It means if primary current is 800 A then secondary current will 1 A. Its burden is 30 VA. So the load connect to the secondary side should under 30 VA for the accuracy. Its accuracy class 0.2 indicates that it used for measurement purpose. The current transformer accuracy under 1 is used for measurement purpose and it accuracy greater than 3, that is used for protection purpose.

Figure 4.10: 145 kV Current Transformer in APSCL.

4.4.2. **Potential Transformer**

Potential transformer is a kind of step down transformer. It steps down the voltage very accurately for the purpose of measurement and protection. The voltmeter and relays that are connecting with potential transformer cannot handle the high voltage of the system. So potential transformer is step downing the voltage level and makes it suitable for measuring and protecting equipments.

The potential transformer is made by ENERGYPAC ENGINEERING LTD. In 132 KV substation potential transformer installed with rated primary voltage is 132 KV and the secondary voltage is 110 V. This is a single phase outdoor type potential transformer with rated frequency 50 Hz. Single phase potential transformer is used because the power transformer is single phase. The ratio is 1200. It means if the primary voltage is 1200 V then the secondary winding voltage will 1 V. It can function in 145 KV system. Here the burden is 60VA. Burden is the measurement of load can connect in the secondary circuit of the potential transformer. Burden has effect on accuracy on potential transformer. If the VA rating of load is greater than the rated burden then the accuracy will decrease. The accuracy of this transformer is 0.2 it indicates that it is used for measurement. The potential transformer accuracy under 1 is used for measurement purpose and it accuracy greater than 3, that is used for protection purpose.

Figure 4.11: 132 kV Potential Transformer in APSCL.

Table 4.1: Nameplate Rating of Potential Transformer in APSCL.

Potential Transformer Made to I.E.C – 60044-2	
Rated Voltage	132kV
Construction	Out Door
No of Phase	Single
Ratio	$\frac{132000}{\sqrt{3}}$ / $\frac{110}{\sqrt{3}}$
Burden	60VA
Serial No	132 P.S 153
Highest System Voltage	145kV
Insulation Level	275/650 kV
Rated Frequency	50 Hz
Total Weight	600 Kgs
Class of Accuracy	0.2
Year of Manufacture	2009

4.5.Circuit Breaker:

Circuit breaker is an electrical switch that automatically operated and designed to protect an electrical circuit from damage. Its basic function is when fault detected then it will immediately discontinue electrical flow. In there are arc extinguishing system.

There is two types of circuit breaker that used in APSCL

1) Oil Circuit Breaker
2) SF6 Circuit Breaker

4.5.1. Minimum Oil Circuit Breaker:

Minimum oil circuit breaker is used in only 132 KV substation. In minimum oil circuit breaker dielectric oil is used as an arc extinguishing medium and dielectric medium. The minimum oil circuit breaker is made by SIEMENS and it is made in GERMANY.

When the breaker is opening then for high voltage arc create. In minimum oil circuit breaker oil comes at high velocity in arcing area and extinguish arc. When current arcs in oil, the oil vaporizes and a bubble forms around the arc.

Its rated voltage is 132 KV and the maximum service voltage is 170 KV. Rated frequency is 50 Hz and rated current is 1250 A. Rated supply voltage of closing and opening devices is 220 volt DC.

Its breaking capacity is 5000 MVA. It is the product of rated voltage and rated breaking current. So the short circuit breaking current is 21.86 KA. Breaking current is the value of current at the instant of contact separation. It is important in calculating the fault level.

Its making current is 55 KA. Making current is the peak value of first current loop of short circuit current and 2.5 times of breaking current. The operating duty of this circuit breaker is O-0.3s-CO-3min-CO. It means, opening operation-0.3 s for circuit breaker to be used for rapid auto reclose-closing and opening-3min for circuit breaker to be used for rapid auto reclose- closing and opening. The second cycle is valid when the circuit breaker is used with re-closing relay. In that case, after the closing operation, the closing springs are charged. Thus, the circuit breaker will be ready for opening and re-closing. Short time current is 32 KA means is the r.m.s value of current that the circuit breaker can carry in fully closed position in 1second.

Oil circuit breakers are maintained in every year such as, clean the breaker, clean the insulator, and check the joints. Check operation of pressure gauges, check accumulator pre-charge pressure and check for oil leaks and low pressure oil tank oil level. Another important is check dielectric strength of oil because after many times operation the dielectric strength and internal pressure decrease.

Figure 4.12: 132 KV Minimum Oil Circuit Breaker in APSCL.

Table 4.2:Nameplate Rating of Minimum Oil Circuit Breaker in APSCL.

SIEMENS			
Year of Constr./ No.	S69/30756803		
Type	H 810-132/1250-5000E		
Rated voltage	System solidly grounded	132	Kv
Max. Service voltage		170	Kv
Rated Current		1250	A
Frequency		50	Hz
Breaking Capacity		5000	MVA
Natural frequency		1.5	kHz
Amplitude factor		1.6	
Making Current		55/43	kA
Short time Current	1sec	32	kA
Operating duty	O-0.3s-CO-3min-CO		
Operating mechanism		220	Vd.c
Weight incl. oil		3280	kg
Oil filling of breaker poles		330	kg
MADE IN GERMANY			

4.5.2. **Sulphur Hexaflouride (SF6) Circuit Breaker:**

SF6 circuit breaker is used in 132 KV and 230 KV substation. In SF6 circuit breaker Sulphur Hexafluoride gas is used as the dielectric and arc extinguishing properties. This is also made by SIEMENS, made in GERMANY.

The SF_6 gas is an electro negative gas so it has a strong tendency to absorb free electrons. When the contact open then high pressure SF6 goes to that area where the arc is produced and extinguishes the arc by capturing free electrons of arc. The SF_6 circuit breakers are very effective for high power and high voltage service.

The SF6 circuit breaker that we observed was in 132 KV substation, rated voltage is 145 KV. Generally SF6 is manufactured with rated voltage of 72.5 KV, 145 KV, 245 KV, 420 KV. Rated frequency is 50 Hz and rated normal current is 3150 A. Rated short circuit duration is 3s and short circuit breaking current is 40 KA. Rated Operating sequence O-0.3s-CO-3min-CO. The rated operating pressure of Sulphur Hexafluoride gas is 6 bar. Control voltage is 220V DC. The breaker can operate from -25^{o}C to +55^{o} C temperature.

Every year breakers are tested and maintained. Around 500 time operation this breaker should maintained. Check SF6 gas pressure and charging mechanism. Inspect the breaker do some test like timing and Insulation resistance test.

Check the connections and joints. Clean the sensitive area of breaker because dust can cause of short circuit or other hazard. The insulation surface is cleaned frequently because dust can break down the insulator function. Before the maintenance work all the power should disconnected, isolator should opened.

Figure 4.13: 145KV SF6 Circuit Breaker in APSCL.

Table 4.3 : Nameplate Rating of SF6 Circuit Breaker in APSCL.

SIMENS	
Type 3APDT / Year of Manufacturing/No	02/35076681
Rated voltage Ur	145 kv
Rated lightning impulse withstand voltage Up	650kv
Rated power frequency withstand voltage Ud	275 kv
Rated frequency fr	50Hz
Rated normal current Ir	3150 A
Rated Short-circuit breaking current Isc	40kA
Rated Duration of short-circuit tk	3s
Rated Out-of-phase breaking current Id	10kA
First-pole-to-clear factor	1.5
Rated Line-charging breaking current Il	50A
Rated Operating sequence 0-0.3s-CO-3min-CO	
Rated pressure of SF6 at +20 C (gauge)	6.0 bar
Weight of SF6 filling	26.0 kg
Weight including SF6	3530 kg
Nominal supply voltage of auxiliary circuits	
Control voltage	DC 220 V
Operating mechanism voltage	AC 240 V
Heating voltage	AC 415/240 V
Temperature class	-25 +55 C
In line With : IEC 60056	

4.6.**Isolator**

In substation, it is needed to disconnect a part of the system for general maintenance and repairs. By isolator it is accomplished. Isolator operates under no load condition because there is no arc extinguishing system. It is used for extra security.

In APSCL substation the horizontal center break type isolator is used. Isolators are well insulated on a steel base. Here is a set of three isolators for three phase line. A mechanical handle connect with three isolators and operate this mechanical hand the isolators are disconnected. It open after circuit breaker open and close before circuit breaker close.

Figure 4.14 : 132 KV Isolator in APSCL.

4.7.**Earth Switch:**

Earth switch is connecter between the line conductor and earth. Normally it is open. When line is disconnected, the earth switch is closed so as to discharge the voltage trapped on the line. Though the line is disconnected, there is some voltage on the line to whish the capacitance between line and earth is charged. This voltage is sufficient in high voltage system. Before starting the maintenance work these voltages are discharged to earth by closing the earth switch.

4.8.**Lightning Arrester:**

A lightning arrester is a protective device which conducts the high voltage surges on the power system to the ground. Lightning is a huge spark. Lightning arrester is also called surge arrester. It consists of a spark gap in series with a non linear resistor.

In APSCL Polymer Metal Oxide arrester, Zinc Oxide arrester and over head lightning arrester is used. In the nonlinear resistor made with metal oxide and zinc oxide. It has a high voltage terminal and a ground terminal. One end of the arrester is connected to the terminal of equipment to be protected and the other end is grounded. Under the normal condition lightning arrester does not work but when the high voltage or thunder strike occur then air insulation of the gap breaks and arc is formed for providing a low resistance path for surge the ground. This is how it saves the electrical equipment.

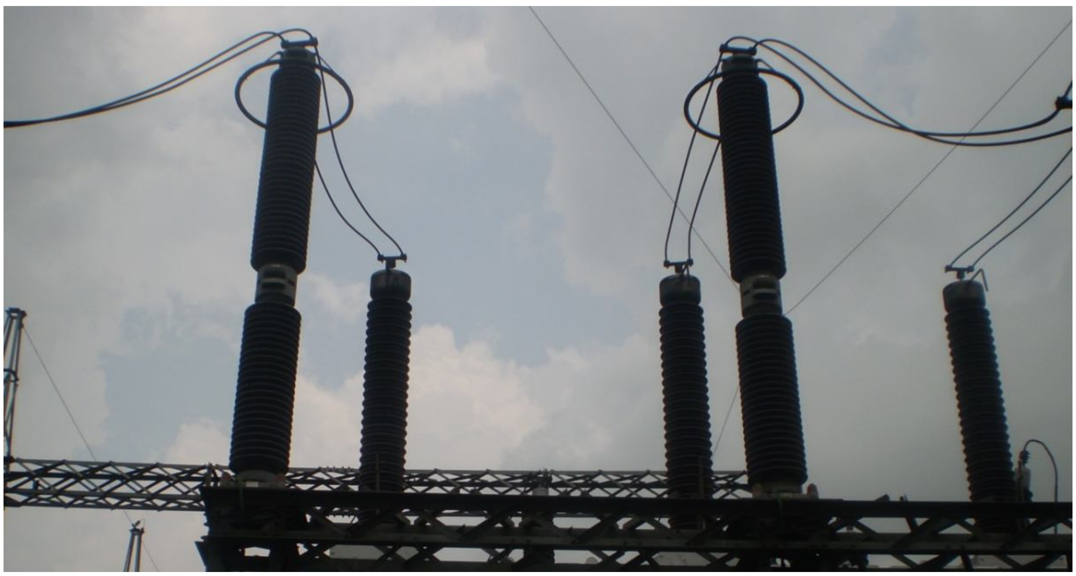

Figure 4.15: Metal Oxide arrester in APSCL.

4.9.**Bus-Bar:**

When a number of lines operating at the same voltage have to directly connect electrically then it is called bus bar. Conductors to which a number of circuits are connected are called Buses. And Bar means rod or metals which help current to flow. Bus bar is used as the common electrical component. The incoming and outgoing lines in a substation are connected to the bus bar.

In APSCL Double bus bar arrangement exists. This system consists of two bus bars, a main bus bar and a spare bus bar. Each bus bar has the capacity to take up the entire substation load. The incoming and outgoing lines can be connected to either bus bar with the help of a bus bar coupler. Generally the incoming and outgoing lines remain connected to the main bus bar. However, in the case of repair of the main bus bar or fault occurring on it, the continuity of supply can be maintained by transferring it to the spear bus bar. The choice of a particular arrangement depends upon various factors such as system voltage, position of substation, degree of reliability, economic consideration, availability, maintenance, safety and cost.

4.10. **Bus Coupler:**

It is used to separate line when a problem is found in a single line then we do not stop the all line. At first we open the line by bus coupler and solve the problem of the particular line.

4.11. **Transmission Line:**

Electric-power transmission is the transfer of electrical energy, from generating power plants to electrical substations and located near demand centers. Electricity is transmitted at high voltages to reduce the energy lost in long-distance transmission. Power is usually transmitted through overhead power lines

(i) Conductors
(ii) Insulators
(iii)Line Supports

4.11.1. **Conductors:**

The transmission of electric power is through the ACSR (Aluminum Conductor Steel Reinforced) conductor. This conductor involves a high-strength core material surrounded by a high-conductivity material. It consists of a solid or stranded steel core surrounded by one or more layers of strands aluminum.

4.11.2. **Insulator:**

Transmission line insulators are devices used to contain, separate or support electrical conductors on high voltage electricity supply networks. Transmission insulators come in various shapes and types, depends on its various application zone. They are made of porcelain.

In APSCL there are two types of Insulator used

Pin Type Insulators

Pin type insulators are used for the transmission of lower voltages. A single pin type insulator is used to transmit voltages up to 11 kV and for higher voltages require more piece pin insulators. But they are not economically feasible for 33 kV and higher transmission lines. Pin type insulators are secured with steel or lead bolts onto transmission poles. These are typically used for straight-running transmission lines.

Figure 4.16: Proceline made Insulator (11KV).

Suspension Type Insulators

Suspension type transmission line insulators suspend and support high voltage transmission lines. They are cost effective for higher voltage transmission than multiple pin type insulators. Suspension type insulators have a number of interconnected porcelain discs, with each individual unit designed to support a particular voltage. And altogether these discs are capable of supporting high voltages. To handle 132 KV substation a set of 10 pin type insulator and to handle 230 KV substation a set of 17 pin type insulator is used.

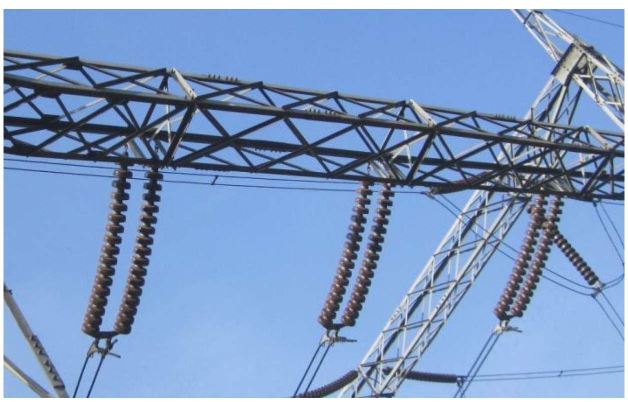

Figure 4.17: Suspension Type Insulator in 230KV substation.

4.11.3. **Line Supports**

The supporting structures for overhead line conductors are called line supports. The line supports used for transmission and distribution of electric power are of various types including wooden poles, RCC poles and lattice steel towers. The choice of supporting structure for a particular case depends upon the line span, transmission area, line voltage, cost and local conditions. In APSCL lattice steel towers are used. For high voltage the transmission line should be very high above the ground. Suitable wooden pole with this height is not available. An RCC pole has limitations on earth quake and need huge structure to achieve height and carry weight of long transmission line. But lattice steel towers is very effective, can carry heavy load and efficient than other poles.

Figure 4.18: Lattice steel towers Line Supports in APSCL.

4.12. **Wave Trap:**

Wave trap is a parallel tuned inductor - capacitor 'tank' circuit made to be resonant at the desired communication frequency. It is the effort to utilize the same transmission line between two substations for the purpose of communications. At this communication frequency the tank circuit provides high impedance and does not allow passing through them & onto the substation bus & into transformers.

Figure 4.19: Wave Trap in APSCL.

4.13. **Outgoing feeder**

Those feeders carry power to consumers. Outgoing feeders of APSCL are:

4.13.1. **132KV Outgoing feeders:**

Ghorashal, Kishoreganj and Shajibaza are covered by the 132 KV transmission line. These are divided into outgoing feeders. The outgoing 132 KV feeders are -

1. Ghorashal-1
2. Ghorashal-2
3. Kishoregonj-1
4. Kishoregonj-2
5. Shajibazar-1
6. Shajibazar-2
7. Shajibazar-3

4.13.2. **230KV Outgoing Feeders:**

Ghorashal and Comilla are covered by the 230 KV transmission line. These are divided into outgoing feeders. The outgoing 230 KV feeders are -

1. Ghorashal-1
2. Ghorashal-2
3. Comilla -1
4. Comilla-2

5. Serajgonj -1
6. Serajgonj -2

SINGLE LINE DIAGRAM of ASHUGANJ SUB-STATION

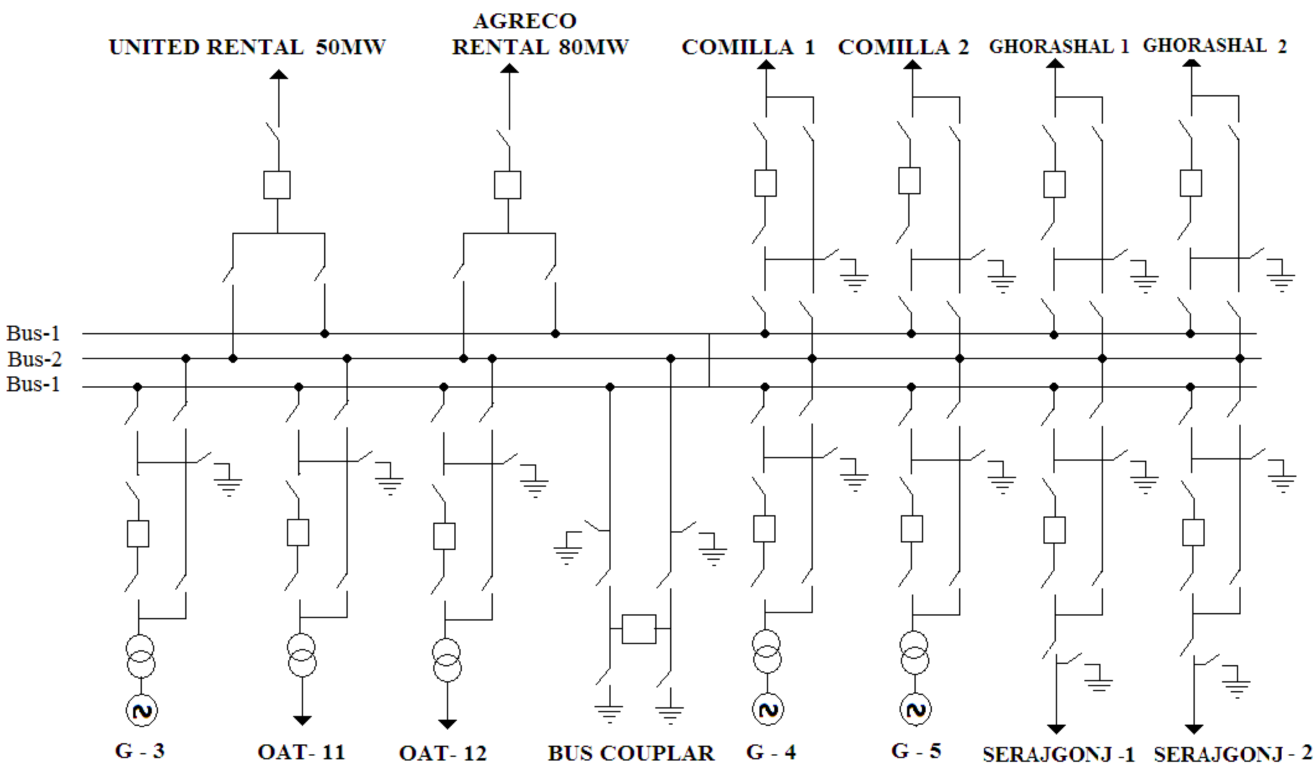

Figure 4.20: Single Line Diagram of APSCL 230 KV Busbar.

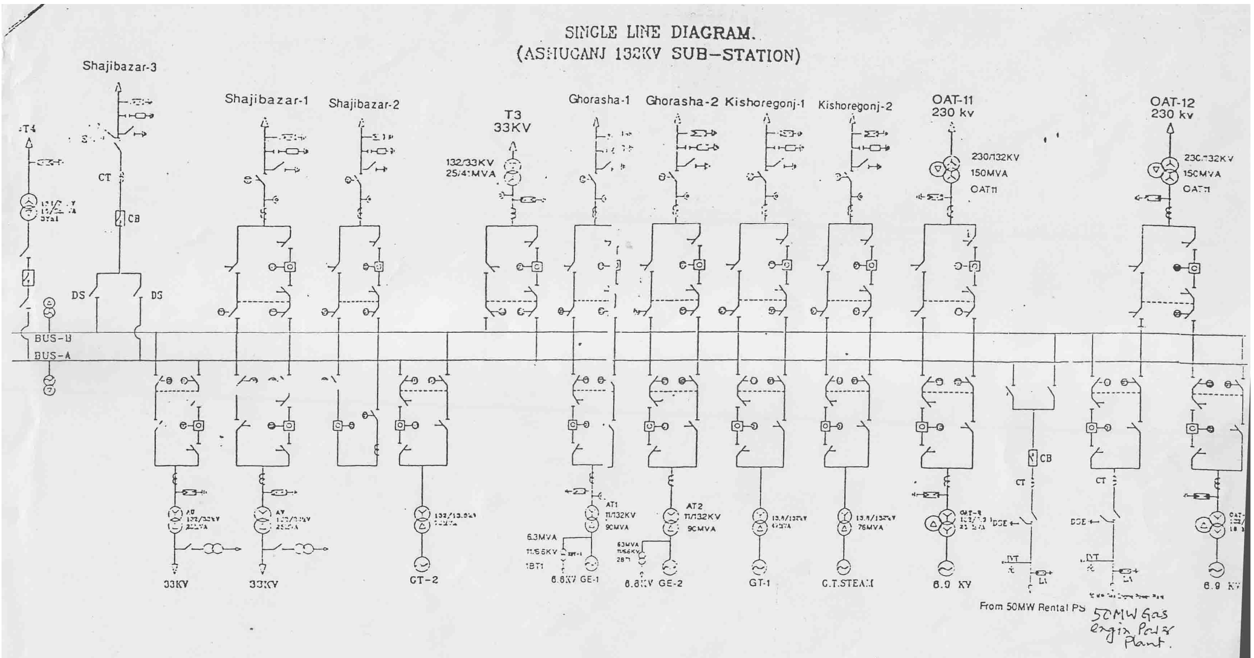

Figure 4.21: Single line diagram of 132 KV Busbar.

4.14. **Conclusion**

In substation the most important element is the power transformer. It changes the voltage parameter. Other equipments are used for protection, measurement and maintenance. Generally current and voltage transformer are connected with measuring and equipments In this chapter we focused on transformer. Also discuss about relay, circuit breaker and lightning arrester is the on load protection of the substation. And isolator and earth switch for the off load protection of substation. At the end of the substation the transmission lines are connected. By this line generated power delivered to the consumers. The proper maintenance in the substation equipments in APSCL has made it possible to supply power to the national grid successively

Chapter: 05

5. INSTRUMENTATION & CONTROL

5.1.Introduction:

Control is the most important part of a power plant. In a power plant everything should be under control such as: fuel flow, steam flow, air flow and many other things, to avoid unexpected event or accident. So for the purpose of controlling and maintenance, it should be a proper instrumentation. That's why instrumentation is also very important part in a power plant. By a proper instrumentation, power plant efficiency can be improve and also maintain properly.

On 09-01-2012, 10-01-2012 and 11-01-2012, we observed the different types of equipment of protection and controlling system and its operation of total Power Plant of APSCL with the help of Engr. Bikash Ranjan Roy(Manager I&C). And we also spent almost 21 hour of our total duration of internship.

Instrumentation and control is directly related with each other, because of for the purpose of controlling, instrumentation is needed. In APSCL, there are many different types of instrument or equipments are used, such as; different types of sensor (Temperature sensor, Water level sensor, Speed sensor, Position sensor, pressure sensor, Bearing temperature sensor), different types of valve (Temperature control valve actuator, Pneumatic control valve, Solenoid valve, Shat-off valve, Regulating valve, Oil pressure control valve, Gas pressure reducing valve), different types of safety valve (Boiler dram safety valve, Super heater safety valve), different types of transmitter (Air flow transmitter, Gas flow transmitter, Pressure transmitter, Level transmitter, Temperature transmitter), Gas heater, Damper, Inlet vent actuator. These instruments are used for controlling, measuring and protection.

In this chapter, we discussed about above equipment and its operation, which we learn and observe during our internship. And we also share our experience in this chapter.

5.2.Instrumentation:

Instrumentation means, installation of different equipment or instrument in a proper place for the purpose of maintenance and controlling. So instrumentation is an important part of a power plant for the purpose of controlling, without instrumentation controlling and maintenance would not possible in a power plant. Sometime instrumentation is also used for protection purpose. So instrumentation is vast thing in a power plant.

In APSCL, different types of instrument or equipment are uses, for the purpose of controlling, maintenance and protection also. Such as a:

5.3.**Gas Pressure Reduction Plant:**

Gas pressure reducing plant is the plant where gas pressure can be reduced by using different types of equipment or instrument. APSCL is a thermal power plant, here all of the units are depends on gas. Because of gas is use here as a fuel. So gas pressure and flow should be maintained as the need of units.

Gas pressure reducing plant, reduced the gas pressure around 35 bar to 4.2 bar, by using of different types of instrument or equipment. Here for reducing the gas pressure and controlling gas flow used different types of control valve like: shut-off valve, isolating valve, solenoid valve and differential valve.

And also use gas heater, gas filter, gas flow counter and different types of meter.

Figure 5.1: Gas Heater of gas pressure reducing plant (Unit 1, 2, 3 & 4).

5.4.**Waste water basin:**

Waste water basin is used here for the purpose of maintenance. Waste water basin, which was used for the purpose of drainages the waste water to the river. Before drainages the waste water it should be maintain some feature such as temperature. So maintain the temperature and drainages the waste water, here use some instrument or equipment, such as a drainage water pump, water level sensor, heat sensor, temperature control actuator valve.

5.4.1. **Drainage water pump:**

Drainages the waste water to the river from waste water basin. Here to drainage pump is present, one is running and one is standby for emergency purpose. When waste water level is exits a minimum level of waste water basin, then pump is automatically turn-on.

Figure 5.2: Drainage Pump of Waste water basin (Unit 3).

5.4.2. **Water level sensor:**

Water level sensor senses the water level in the waste water basin. Here, two water level sensors are present. It senses the water level of waste water basin, when waste water exits a minimum level then it sends a signal to the drainage water pump.

Figure 5.3: Water Level Sensor of waste water basin (Unit 3).

5.4.3. **Heat sensor:**

Heat sensor senses the waste water heat in the waste water basin. Here two heat sensors are use, when waste water heat becomes very high; it sends a signal to the temperature control actuator valve.

Figure 5.4: Temperature Sensor of waste water basin (Unit 3).

5.4.4. Temperature control actuator valve:

Temperature control actuator valve, it is special types of valve which is controlled by the temperature. It is used in the waste water basin for the purpose of mixing of the cooling water. When waste water heat become very high then it receives a signal from the heat sensors and then it opens automatically. When waste water heat becomes normal it close automatically.

Figure 5.5: Temperature Control Actuator valve of waste water basin (Unit 3).

5.5.Force Draft Fan:

Force draft fan is a fan, which draws air from the atmosphere for the purpose of combustion. So for the purpose of air flow control and the protection of force draft fan, here use some equipment or instrument, such as:

5.5.1. **Damper:**

Damper is a mechanical device which controls the air flow of force draft fan. Damper is the device, which operating mechanism is either fully open or fully close. For every force draft fan it has a damper in the air inlet chamber.

Figure 5.6: Damper of Force draft fan (Unit 4).

5.5.2. **Force draft fan inlet vent actuator:**

Force draft fan inlet vent actuator, is also a mechanical device which control the air flow of force draft fan. But it is operating with the mechanism of 0-100% open or close. It can control the air flow as a need of combustion. Like damper every force draft fan inlet vent has an inlet vent actuator.

Figure 5.7: Inlet Vent Actuator of Force draft fan (Unit 4).

5.5.3. **Winding temperature protection of force draft fan:**

For the purpose of force draft fan winding protection, every force draft fan has a few temperature sensors and meter. When winding temperature rises at a certain point, temperature sensors sense the temperature and sent a signal to the control room and protect the winding from destructions.

Figure 5.8: temperature sensor & meter of FD fan (Unit 4).

5.6.Turbine control panel and protection system:

For the purpose of turbine control and protection, here use different types of sensor, valve and transmitter. This sensor and valve are basically use for the controlling steam flow and measured the temperature and others.

5.6.1. Turbine control panel:

Turbine control panel consists of different types of meter, transmitter, valve, switches, and sensors. Which are basically used for the purpose of controlling, measuring, transmitting and protecting of the turbine, these devices can be control by remotely or locally. Such as:

Figure 5.9: Turbine Control Panel Of Steam turbine generator plant (Unit 3).

1. Temperature meter:

Temperature meter shows this reading which was measured by the thermocouple. Basically it is used for local use only. Turbine temperature should be under control because excessive temperature can trip the system because of it has possibility to harm the turbine.

Figure 5.10: Temperature sensor & meter of turbine (Unit 3).

2. Thermocouple:

Thermocouple is the measuring device, which is used for the purpose of temperature measuring. Here many thermocouples are use in different places for the purpose of measuring turbine temperature and send the reading to the control room.

Figure 5.11: Thermocouple (Unit 3).

3. Shut-off valve:

Shut-off valve is a one kind of pneumatic control valve, which control by the air. Here shut-off valve is use for the purpose of emergency stop of steam flow, so it’s called also emergency stop valve. When any fault occurs in the generator or bus bar, it should be stop its generation first, for the purpose of stopping generation it should be stop its steam flow. So for the emergency case here used shut-off valve for stopping the steam flow.

Figure 5.12: Shut-off valve of turbine (Unit 3).

4. Regulating valve:

Regulating valve is also a pneumatic control valve, which is operated by the air. Here regulating valve is used, for the purpose of controlling the steam flow. Steam flow should be reduces or increases depending on load, when loan will increases steam flow should be increases and when load will decreased steam flow should be decreases. This operation is done by the help of regulating valve.

Figure 5.13: Regulating valve of turbine (Unit 3).

5. Shaft Vibration sensor:

Shaft vibration sensor is an electrical device, which senses the shaft vibration and protects the system from the trip. Because if the shaft vibration exits a certain level it has possibility to become unbalance and due to unbalance it has possibility to break the turbine blade. So a shaft vibration sensor senses the vibration and sent it to the control room and protects the system.

6. Shaft position sensor:

Shaft position sensor is an electrical device, which senses the shaft position and protects the system from the trip. Shaft position sensor senses the shaft position and protects the system from the unbalance.

Figure 5.14: Shaft position sensor of turbine (Unit 3).

7. Turbine Speed sensor:

Turbine speed is an electrical device, which senses the turbine speed and sent to the control room and protect the system from the over speed trip.

5.6.2. **Protection system:**

By the use of this instrument or equipment, system can protect the turbine. These instruments are basically valve and sensor, which protects the turbine, such as:

- Over speed trip 110% and 112%.
- Shaft vibration trip.
- Shaft position trip.
- Vacuum trip.
- Turbine temperature trip.
- Lube oil trip 40% and 60%.

5.7.**Boiler control panel and protection system:**

For the purpose of boiler operation control and protection, here use different types of sensor and valve. This sensor and valve are basically used for the controlling gas flow, and measured the temperature and others.

5.7.1. **Boiler control panel:**

For the purpose of boiler operation control and protection, here use different types of sensor, valve, meter and transmitter. This sensor and valve are basically use for the controlling the different types of flow and measuring purpose.

1. Steam pressure reducing valve:

Steam pressure reduce valve, which is use for the purpose of reducing steam pressure in different place of the plant for different purpose. Here steam pressure reduce valve is used in a auxiliary steam flow pipeline for reducing steam pressure for auxiliary using purposes. These kinds of valves are normally control by pneumatic operation.

Figure 5.15: Steam pressure reducing valve (Unit 4).

2. Gas flow transmitter:

Gas flow transmitter, which is used for the purpose of measuring the gas flows passing through the pipe. The transmitter measured the gas flow by using differential pressure of the pipeline in different point, and transmitted to the control room.

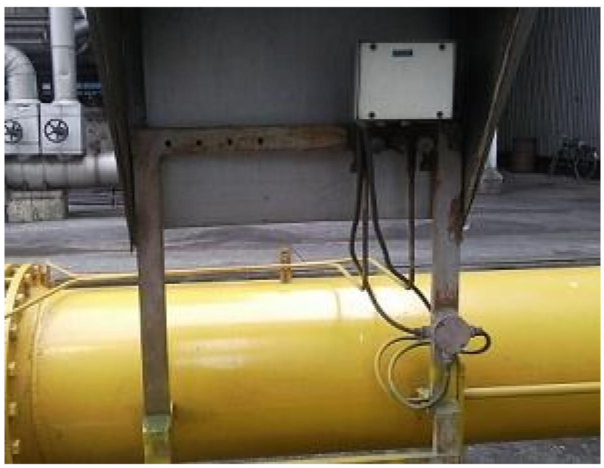

Figure 5.16: Gas flow transmitter (Unit 4).

3. Air flow transmitter:

Air flow transmitter is an electrical device, which is used for the purpose of measuring the air flow through the force draft fan inlet vent section and transmitted to the control room. As like as a gas flow transmitter, air flow transmitter measure the air flow by using differential pressure.

Figure 5.17: Air flow transmitter (Unit 3)

4. Supper heater safety valve:

Supper heater is a part or stage of the boiler, where steam become supper heated under certain temperature such as 950ºC to 400 ºC. Here steam become supper steam and goes to the turbine.

In this condition, supper heater steam pressure should be maintained such as 24.3mber to 24.1mber. If the pressure of the supper heater exits this certain level, it has some safety valve called supper heater safety valve. Its exhaust the extra steam or pressure through this valve.

Figure 5.18: Supper heater safety valve (Unit 3 Boiler).

5. Thermostat:

Thermostat is an electrical device, which measured the temperature inside of the boiler. Here total six thermostats are present, which shows the temperature inside of the combustion chamber.

Figure 5.19: Thermostat of boiler (Unit 3, Boiler).

6. Boiler drum water level detector:

Boiler drum water level detector is an electrical device, which detect the water level of the boiler drum and protect the system from boiler drum trip. Boiler drum should maintain a certain level of water and such as: 50% water and 50% steam, due to fault occurrence if boiler drums water level exits 80% or less than 20%. It sent a trip signal to the control room and trip the system.

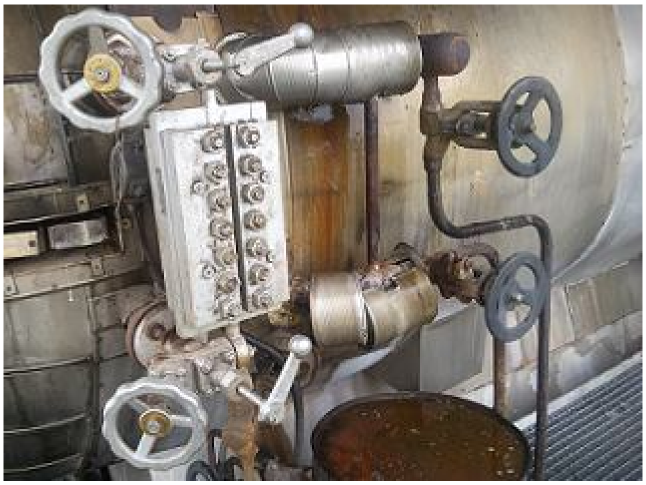

Figure 5.20: Boiler drum water level detector (Unit 2, Boiler).

7. Boiler drum water level transmitter:

Boiler drum water level transmitter is an electrical (SIMNCE) device, which receives a signal from boiler drum water level detector about the level of water and sends it to the control room for the purpose of maintenance.

Figure 5.21: Boiler drum water level transmitter (Unit 2, Boiler).

8. Boiler drum Pressure meter:

Boiler drum pressure meter is a mechanical device, which shows the boiler drum steam pressure. It is a pneumatic control meter. Boiler should maintain a certain level of pressure and temperature such as: 139 to 141bar and 294ºC.

Figure 5.22: Boiler drum pressure meter (Unit 2, Boiler).

9. Boiler drum safety valve:

Boiler drum safety valve is also a mechanical device, which is used for the purpose of releases the extra pressure or steam from the boiler drum. It is a pneumatic control valve, whose operation is controlled by the air pressure. Boiler drum should maintain a certain level of pressure such as 139 to 141bar, if it is exits the certain level of pressure then automatically boiler drum safety valve will open and its releases the extra pressure or steam.

Figure 5.23: Boiler drum safety valve (Unit 2, Boiler).

5.7.2. **Protection system:**

By the using of this instrument or equipment, system can protect the boiler from the unwanted event. These instruments are basically valve, sensor and transmitter, which protect the boiler, such as:

(i) Boiler drum water level trip greater than 80%.

(ii) Boiler drum water level trip less than 20%.

(iii) Supper heater safety valve trip.

5.8. **Different types of pump protection instrument or equipment:**

Different types of pumps are used in the power plant for different purposes. Such as a circulating water pump, feed water pump, different types of suction pump, drainage pump, cooling water pump, condensate pump. This pumps are plays a vital rule in a power plant. So every power plant, for the purpose of protection, used different types of protection equipment.

5.8.1. **Cooling water pump winding protection:**

For the purpose of cooling water pump protection, here used different types of temperature sensor such as bearing temperature sensors and winding temperature sensors, and also used different types of temperature meter and transmitter.

5.8.2. **Feed water pump bearing temperature measuring equipment:**

For the purpose of feed water pump bearing temperature measuring, here used different types of sensors and meter. For the cooling purpose here used lube oil.

5.8.3. **Working oil pressure sensor for feed pump:**

In the feed water pump, lube oil is used for the cooling purpose; this lube oil pressure should be maintained. So here different types of sensors are used.

5.8.4. **Condensate pumps protection:**

Condensate pump draw the condensed water from condenser, and carried out to feed water tank through the LP heater1 & 2. So condensate pump should be protected.

5.9.**Conclusion:**

Instrumentation and controls are directly related to each other, because without instrumentation controlling, measuring and protection could not possible. Instrumentation means, place a right instruments or the equipments in the proper place, for the purpose of measuring, transmitting and controlling. In this chapter, we discussed about Instrumentation & Controlling system of APSCL, which contain different types of controlling valve and metering instruments. These instruments are different types of transmitter, sensor, valve, heater, damper etc, such as; Transmitter (Air flow transmitter, Gas flow transmitter, Pressure transmitter, Level transmitter, Temperature transmitter), Sensor (Temperature sensor, Water level sensor, Speed sensor, Position sensor, pressure sensor, Bearing temperature sensor), Control Valve (Temperature control valve actuator, Pneumatic control valve, Solenoid valve, Shat-off valve, Regulating valve, Oil pressure control valve), Safety Valve (Boiler dram safety valve, Super heater safety valve), Heater and Damper. These instruments are helps to run APSCL properly.

Chapter: 06

6. PROBLEMS AND RECOMMENDATIONS

6.1. Observation:

In APSCL engineers are very helpful; they help us as much as possible, in every place. Our major courses are helping us to understand the plant equipment and total system of the plant.

The purpose of understanding easily, APSCL's engineers dividing the total system into five section, such as a;

(i) Generation section
(ii) Sub-station section
(iii) Combine cycle power plant section
(iv) Instrumentation & control section
(v) Operation section

We observed the every section almost three days each with the help of this sections manager or senior engineers.

6.2. Problem:

We faced a few problems when we work in APSCL. Such as:

(i) We were not allowed entering the every place of the plant such as; sub-station due to risk of high voltage.
(ii) Sometimes we could not collect our necessary data or information due to privacy of administration.
(iii) Sometimes, when plant was trip, the engineers could not give us proper time because they are busy with their works.

6.3. Recommendation:

In APSCL there is different types of plants are present, such as combined cycle (gas turbine & steam turbine), Gas engine, and steam turbine with different capacity. That's why APSCL is better than other power plant for internship.

Our major courses are very important for understanding the plant equipment & system, so it must be completed before going to internship.

Chapter: 07

7. CONCLUSION

7.1.Environmental Awareness of APSCL

Ashuganj power station company limited is aware of impact of uses of chemicals, lubricants, and transformer oil, and dumping eater into the river. All the issues are mitigated with proper measures. The power plant and its residential areas are kept clean.

7.2.Risk, Uncertainty and Challenges

The directors consider the following risk and challenges are running after APSCL.

1) Average age of plant is 20 to 35years.
2) Overall thermal efficiency and reliability is not up to the mark
3) Therefore APSCL challenges are:
4) Replacement of old inefficient outlived plant
5) Implementation of new projects
6) Increase of station capacity
7) Increase of overall thermal efficiency.

7.3.Conclusion:

Electricity is the driving force of economy and civilization. All other development activities are directly or indirectly dependent on it. The present generation capacity of the country is not sufficiently enough to meet the prevailing load of demand of the country. It causes hindrance to the development activities in industrial, commercial, agricultural, and other social sectors.

Keeping this view in mind, APSCL is continuously working to narrow the increasing gap between demand and supply of electricity in our country.

8. APPINDEX

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